APPLICATION FOR INCIDENTAL HARASSMENT AUTHORIZATION TO NMFS

FOR OPEN WATER SEISMIC OPERATIONS IN THE CHUKCHI SEA

Submitted by ConocoPhillips Alaska, Inc. (CPAI)

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1. Description of the Specific Activity or Class of Activities that can be Expected to Result in Incidental Taking of Marine Mammals.

ConocoPhillips Alaska, Inc. (CPAI) is planning to conduct open water seismic data acquisition during the summer of 2006. The operation will be active 24 hours per day. The seismic vessel currently planned for use is the MV Patriot, owned by WesternGeco. The project is anticipated to start in July and continue through late November depending on ice conditions.

Deep seismic surveys use the "reflection" method of data acquisition. Reflection seismic exploration is the process of gathering information about the subsurface of the earth by measuring acoustic (sound or seismic) waves, which are generated on or near the surface. Acoustic waves reflect at boundaries in the earth that are characterized by acoustic impedance contrasts. The acoustic impedance of a rock layer is its density multiplied by its acoustic velocity. Geophysicists commonly attribute different rock characteristics to different acoustic impedances. Seismic exploration uses a controlled energy source to generate acoustic waves that travel through the earth (including water and sub-sea geologic formations), and then uses receiving sensors to record the reflected energy transmitted back to the surface. Energy that is directed into the subsurface takes on numerous forms. When acoustic energy is generated, compression (p) and shear (s) waves form and travel in and on the earth. The compression and shear waves are affected by the geological formations of the earth as they travel in it and may be reflected, refracted, diffracted or transmitted when they reach a boundary represented by an acoustic impedance contrast.

The basic components of a seismic survey include an energy source, which generates a seismic signal; a receiver system, such as hydrophones or geophones; and electronic equipment to amplify and record the signal. The number and placement of sensors, the energy sources, the spacing and placement of energy input locations, and the specific techniques of recording reflected energy are broadly grouped as "parameters" of a given seismic exploration program.

The scope of this application is limited to seismic exploration activities during the open water season in federal waters in the Outer Continental Shelf of the Chukchi

Sea, offshore Alaska. The energy source for the proposed activity will be air gun array systems towed behind the vessel. There will be 6 to 8 cables approximately 4,000 meters in length spaced 100 meters apart. Each source array consists of identically tuned Bolt gun sub-arrays operating at 2000 psi air pressure. The arrays will fire on interleaved 50-meter intervals and they are designed to focus energy in the downward direction. The proposal is to have two air-gun arrays, each approximately 1695 cubic inches in size and spaced approximately 50 meters apart. Together the two arrays will be approximately 3390 cubic inches in size. The airgun array will fire approximately every 25 meters as the vessel is traveling at 4 to 5 knots. The sub-array is composed of six tuning elements; two 2-gun clusters and four single guns. The clusters have their component guns arranged in a fixed side-by-side fashion with the distance between the gun ports set to maximize the bubble suppression effects of clustered guns. A near-field hydrophone is mounted about 1 meter above each gun station (one phone is used per cluster), one depth transducer per position is mounted on the gun's ultrabox, and a high pressure transducer is mounted at the aft end of the sub-array to monitor high pressure air supply. All the data from these sensors are transmitted to the vessel for input into the onboard systems and recording to tape. See Appendix A for additional information on the array configuration.

The pressure field given off by the airguns was modeled with a commercial package called Nucleus. The software has an internal sample rate of 0.5 ms and is therefore limited to a frequency range of 0-1000 Hz. The modeling algorithm assumes infinitely deep water and no interaction with the seafloor. Pressure values are given for the horizontal plane at 20 meters below the surface. Pressure values for the safety radii determination were taken from aerial amplitude plots (see Attachment A). The source directivity is slightly asymmetrical and the signal is strongest along the in-line direction with the vessel.

The goal of the project is to gather seismic data over 2500 to 3600 square kilometers, weather and ice conditions permitting. CPAI anticipates a work schedule of approximately 90-100 days with about 30% downtime due to weather, ice conditions, repairs etc. Figure 1 is attached indicating the maximum extent of the seismic activity. In addition to the primary activity of the seismic vessel, there will also be support vessels. A supply vessel and a fuel bunkering vessel will be employed to bring supplies to the seismic vessel. The seismic crew will most likely be changed out by helicopter and fixed-wing support may be used to report ice conditions if necessary.

2. The Date(s) and Duration of Such Activity and the Specific Geographical Region Where it will Occur.

CPAI seeks incidental take authorization for a period of five months (1 July through 30 November 2006). Mobilization of operations will occur in mid-July, and seismic operations are proposed to begin in late July. Open water seismic operations are ordinarily confined to no more than this five-month period because of the timing of ice melt and formation, which occur closer to four months in a typical year. The geographic region of activity encompasses a 2500 – 3600 sq km-area in the northeastern Chukchi Sea (Figure 1). The approximate boundaries of the region are within158º00’W and 169º00’W and 69º00’N and 73º00’N with eastern boundary located parallel to the coast of Alaska, north of Point Hope to Point Barrow, and ranging 40-180 km off the coast. The nearest approximate point of the project to Point Hope is 74 km, Point Lay 90 km, Wainwright 40 km, and Barrow 48 km. Water depths are typically less than 50 m.

3. Species and Numbers of Marine Mammals Likely to be Found within the Activity Area

A total of five cetacean and three pinniped species are known to occur in the project area. One of the species, the bowhead whale, is listed as Endangered under the Endangered Species Act (ESA). Polar bears and the Pacific walrus also occur in the project area, but they are not addressed in this application. The U.S. Fish and Wildlife Service manages both of these species.

The table below summarizes the estimated abundance and ESA status of each species, which is more fully described in question number 3 to minimize redundancy in the application.

Species	Estimated Abundance	ESA Status
Bowhead Whale	10,545	Endangered
Beluga Whale (Beaufort Sea)	39,258	-
Beluga Whale (E. Chukchi Sea)	3,710	
Gray Whale	18,813	-
Killer Whale	≈ 100	-
Minke Whale	No est. available	-
Ringed Seal	> 249,000	-
Bearded Seal	250,000-300,000	-
Spotted Seal	59,214	-

4. Description of the Status, Distribution, and Seasonal Distribution (When Applicable) of the Affected Species or Stocks or Marine Mammals Likely to be Affected by such Activities.

The information developed for the technical elements of the application was derived from published and unpublished literature, personal communications with marine mammal scientists, published IHA applications, and CPAI.

Bowhead whale: Bowhead whales only occur at high latitudes in the northern hemisphere and have a disjunct circumpolar distribution (Reeves 1980). They are one of only three whale species (beluga and narwhal) that spend their entire lives in the Arctic. Bowhead whales occur in the western Arctic (Bering, Chukchi, and Beaufort Seas), the Canadian Arctic and West Greenland (Baffin Bay, Davis Strait, and Hudson Bay), the Okhotsk Sea (eastern Russia), and the Northeast Atlantic from Spitzbergen westward to eastern Greenland. The proposed activity will only occur within the range of the Bering-Chukchi-Beaufort Sea stock, which is the largest of the four stocks. The stock is classified as endangered under the Endangered Species Act (ESA) and depleted under the Marine Mammal Protection Act (MMPA).

The Bering-Chukchi-Beaufort stock of bowhead whales was estimated at 10,400 to 23,000 animals in 1848, before commercial whaling decreased the stock to between 1,000 and 3,000 animals by 1914 (Woodby and Botkin,1993). This stock has slowly increased since 1921 when commercial whaling ended, and now numbers approximately 10,545 whales with an estimated 3.4 to 3.5% annual rate of increase (Brandon and Wade 2004, and George et al. in press, Angliss and Outlaw 2005). Shelden et al. (2001) suggested that the Bering-Chukchi-Beaufort stock should be delisted under the ESA, since its population now exceeds 10,000 animals.

The Bering–Chukchi–Beaufort stock winters in the central and western Bering Sea and largely summers in the Canadian Beaufort Sea (Moore and Reeves 1993, Brueggeman 1982). Spring migration from the Bering Sea follows the eastern coast of the Chukchi Sea to Point Barrow in nearshore leads from mid March to mid June before continuing through the Western Beaufort Sea through offshore ice leads (Braham et al. 1984; Moore and Reeves 1993). Some bowheads arrive in coastal areas of the eastern Canadian Beaufort Sea and Amundsen Gulf in late May and June but most may remain among the offshore pack ice of the Beaufort Sea until mid summer. After leaving the Canadian Beaufort Sea, bowheads migrate westward from late August through mid- or late October. Fall migration into Alaskan waters is primarily during September and October. However, in recent years a small number of bowheads have been seen or heard offshore from the Prudhoe Bay region during the last week of August (Treacy 1993; LGL and Greeneridge 1996; Greene 1997; Greene et al. 1999; Blackwell et al. 2004). Consistent with this, Nuiqsut whalers have stated that the earliest arriving bowheads have apparently reached the Cross Island area earlier than in past years (C. George, personal communication).

The Minerals Management Service (MMS) has conducted or funded late-summer/autumn aerial surveys for bowhead whales in the Alaska Beaufort Sea since 1979 (e.g., Ljungblad et al. 1986, 1987; Moore et al. 1989; Treacy 1988-1998, 2000, 2002a,b). Bowheads tend to migrate west in deeper water (farther offshore) during years with higher-than average ice coverage than in years with less ice (Moore 2000). In addition, the sighting rate tends to be lower in heavy ice years (Treacy 1997:67). During fall migration, most bowheads migrate west in waters ranging from 15 to 200 m deep (Miller et al. 2002 in Richardson and Thomson 2002); some individuals enter shallower water, particularly in light ice years, but very few whales are ever seen shoreward of the barrier islands. Survey coverage far offshore in deep water is usually limited, and offshore movements may have been underestimated. However, the main migration corridor is over the continental shelf.

Bowhead whales typically reach the Barrow area during their westward migration from the feeding grounds in the Canadian Beaufort Sea in mid-September to late October. However, over the years, local residents report having seen small numbers of bowhead whales feeding off Barrow or in the pack ice off Barrow during summer (Craig George, personal communication). Bowhead whales may feed opportunistically where food is available as they migrate through the Alaskan Beaufort Sea. Recent carbon-isotope analysis of bowhead whale baleen suggests the Chukchi and Bering seas may be the predominant feeding areas for adult and juvenile bowhead whales (Schell et al. 1987; Schell and Saupe 1993, Lee et al. 2005). Examination of stomach contents from whales taken in the Iñupiat subsistence harvest indicates that bowhead whales feed on a variety of invertebrates and small fishes (Lowry 1993). Bowhead whales complete their annual cycle by migrating diagonally along a southwest to northeast vector across the Chukchi Sea down its western coast to the Bering Sea (Miller et al., 1985).

Beluga Whale: In Alaska, beluga whales comprise five distinct stocks: Beaufort Sea, eastern Chukchi Sea, eastern Bering Sea, Bristol Bay, and Cook Inlet (O'Corry-Crowe et al. 1997). For the proposed project, only the Beaufort Sea stock and eastern Chukchi Sea stock will be encountered. Some eastern Chukchi Sea animals enter the Beaufort Sea in late summer (Suydam et al. 2001). Beluga whales from the eastern Chukchi Sea stock are an important subsistence resource for residents of the village of Point Lay, adjacent to Kasegaluk Lagoon, and other villages in northwest Alaska.

The Beaufort Sea population is estimated to be in excess of 39,258 whales (Angliss and Outlaw, 2005). An estimated 2,500-3,000 beluga whales summer in the northwestern Beaufort and Chukchi seas, with some using coastal areas such as Peard Bay and Kasegaluk Lagoon (Frost et al. 1988, 1993 *cited in* USDI MMS 2003). This eastern Chukchi Sea stock was estimated at a minimum of about 3,710 whales (Angliss and Outlaw 2005). This population is not considered by NMFS to be a strategic stock and is believed to be stable or increasing (DeMaster 1995).

The Beaufort stock of beluga whales winter in the Bering Sea, summer in the eastern Beaufort Sea, and migrate around western and northern Alaska (Angliss and Lodge 2002). Most of these belugas migrate into the Beaufort Sea in April or May, although some whales may pass Point Barrow as early as late March and as late as July (Braham et al. 1984; Ljungblad et al. 1984; Richardson et al. 1995). Much of this stock enters the Mackenzie River estuary during July–August to molt, but they spend most of the summer in offshore waters of the eastern Beaufort Sea and Amundsen Gulf (Davis and Evans 1982; Harwood et al. 1996; Richard et al. 2001). Belugas are rarely seen in the central Alaskan Beaufort Sea during summer. During late summer and autumn, most belugas migrate far offshore near the pack ice front (Frost et al. 1988; Hazard 1988. However, during the westward migration in late summer and autumn, small numbers of belugas are sometimes seen near the north coast of Alaska (e.g., Johnson 1979). Nonetheless, the main fall migration corridor of beluga whales is ~100+ km north of the coast. Satellite-linked telemetry data show that some belugas migrate west considerably farther offshore, as far north as 76ºN to 78ºN latitude (Richard et al. 1997, 2001).

The eastern Chukchi Sea stock seasonally inhabits the coastal areas off Alaska. Belugas have been predictably sighted near the Kasegaluk Lagoon from late June through mid to late July (Suydam et al. 2001). Lowry (2001) satellite-tagged five male belugas in Kasegaluk Lagoon in June/July 1998, and found that one beluga remained relatively nearshore where there was a large group of animals near Icy Cape and in the ice just offshore on 6 July; four belugas moved north of Point Barrow into deep offshore Arctic Ocean waters with heavy ice cover; and three traveled about 1100 km north of the Alaska coast (Lowry et al. 1999 in Lowry 2001). Brueggeman et al. (1990, 1991, 1992) recorded as many as 1,276 sightings of beluga whales west and southwest of Point Barrow during more than 1173 hr of vessel survey and over 40 flights in summer to early fall (July to October) of five oil and gas prospects in the Chukchi Sea; over 90% of the belugas were in a single group at Kasegaluk Lagoon on July 1. These data suggest the stock ranges over a broad area including considerably north of Alaska.

Gray Whale:

There are two gray whale populations in the North Pacific based on geographic separation and an increase in the size of one population but not the other (Swartz et al. 2000). The small western North Pacific Ocean population, which summers near Sakhalin Island off Asia, is far from the proposed project area. The larger eastern North Pacific Ocean population summers in the Bering, Chukchi, and western extreme of the Beaufort Sea and largely winters in the lagoons off Mexico. The population is currently estimated at 18,813 whales based on the mean of the 2000/01 and 2001/02 estimates derived by Rugh et al. (2005). Based on the current population trend and estimates, Rugh et al. (2005) and Wade and Perryman (2002) stated that the population is near or at carrying capacity. The eastern North Pacific stock is not listed under ESA or considered by NMFS to be a strategic stock.

Most summering gray whales congregate in the northern Bering Sea, particularly off St. Lawrence Island and in the Chirikov Basin (Moore et al. 2000a), and in the southern Chukchi Sea. More recently, Moore et al. (2003) suggested that gray whale use of Chirikov Basin has decreased, likely from the combined effects of changing currents resulting in altered secondary productivity dominated by lower quality food. The northeastern-most of the recurring feeding areas is in the northeastern Chukchi Sea southwest Barrow (Clarke et al. 1989, Brueggeman et al. 1992). Brueggeman et al. (1992) reported 258 gray whale sightings within the pack ice west and southwest of Barrow in the Chukchi Sea during aerial and vessel surveys in 1991.

Only a small number of gray whales enter the Beaufort Sea east of Point Barrow from the Chukchi Sea. Hunters at Cross Island (near Prudhoe Bay) took a single gray whale in 1933 (Maher 1960). Only one gray whale was sighted in the central Alaskan Beaufort Sea during the extensive aerial survey programs funded by MMS and industry from 1979 to 1997. However, during September 1998, small numbers of gray whales were sighted on several occasions in the central Alaskan Beaufort (Miller et al. 1999; Treacy 2000). More recently, a single sighting of a gray whale was made on 1 August 2001 near the Northstar production island (Williams and Coltrane 2002). Several single gray whales have been seen farther east in the Beaufort Sea (Rugh and Fraker 1981; LGL Ltd., unpubl. data), indicating that small numbers must travel through the region during some summers. In recent years, ice conditions have become lighter near Barrow, and gray whales may have become more common. In the springs of 2003 and 2004, a few tens of gray whales were seen near Barrow by early-to-mid June (LGL Ltd and NSBDWM, unpubl. data). Consequently, the northeastern Chukchi Sea is a feeding area and transition area for small number of gray whales inhabiting the Beaufort Sea in summer.

Killer Whale: Killer whales are known to inhabit almost all coastal waters of Alaska, extending from the Chukchi and Bering seas into the Beaufort Sea. Killer whales appear to prefer coastal areas, but are also known to occur in deep water (Dahlheim and Heyning 1999). Killer whales are uncommon in the Chukchi and Beaufort seas based on the paucity of sightings by researchers. Brueggeman et al. (1992) reported a pod of 12 killer whales southwest of Barrow in Peard Bay during aerial surveys conducted in 1991. There have been sightings of killer whales off Barrow, Point Lay, Peard Bay, and Point Hope by natives but none in the last ten years, suggesting they are present but uncommon in the project area (George and Suydam 1998). While there is no current population estimate for the project area, ADFG (1994) provided an estimate of about 100 killer whales in the Bering Sea in the early 1990s.

Minke Whales:

Very little is known about minke whale use of the Chukchi Sea. Sightings are infrequently reported during the open water season. Brueggeman et al. (1990) reported one minke whale in the northeastern Chukchi Sea during extensive vessel and aerial surveys from 1989 through 1991. There are no estimates for minke whales in the Chukchi Sea, but numbers are clearly very low because it is the northern extreme of its range.

Ringed Seals:

Ringed seals have a circumpolar distribution, which is closely associated with sea ice. Ringed seals are found throughout the Bering, Chukchi, and Beaufort Seas (Angliss and Outlaw 2005). They are the most abundant and widely distributed seal in the Chukchi and Beaufort Seas (King 1983).

Although there are no recent population estimates for the Alaska arctic, Bengston et al. (2005) estimated ringed seal abundance from Barrow south to Shismaref in the Chukchi Sea to be 252,488 (SE=47,204) for 1999 and 208,857 (SE=25,502) in 2000 for an average of 230,673 seals. Frost et al (2002) estimated a density of 0.98 km^2 seals for 18,000 km^2 surveyed in the Beaufort Sea, which Angliss and Outlaw (2005) combined with the average estimate from Bengston et al. (in review) for a total minimum estimate of 249,000 ringed seals in the Beaufort and Chukchi seas. This is a minimum estimate, since Frost et al (2002) and Bengston et al (2005) surveyed a small part of the ringed seal habitat in the Beaufort and Chukchi Seas and Frost et al. (2002) did not correct for missed seals.

Results from surveys by Bengston et al (2005) in May and June of 1999 and 2000 indicated ringed seal densities are higher in nearshore fast ice and pack ice, and lower in offshore pack ice, which is less stable and extensive. However, in some areas where there is limited fast ice but wide expanses of pack ice, the total numbers of ringed seals on pack ice may exceed those on shorefast ice (Burns 1970; Stirling et al. 1982; Finley et al. 1983). Frost et al. (2004) reported slightly higher ringed seal densities in the pack ice (0.92-1.33 seals/km2) than in the shorefast ice (0.57-1.14 seals/km2) in the central Beaufort Sea during late May and early June of 1996-1999, when seals are most commonly hauled out on the ice. Wiig et al., (1999) found highest seal densities on stable landfast ice, but significant numbers of ringed seals also occur in pack ice. During summer, high densities of ringed seals are associated with ice remnants (Burns et al. 1980 *cited in* USDI MMS 2003). Brueggeman et al. (1990, 1991, 1992) recorded as many as 668 sightings of ringed seals west and southwest of Point Barrow during more than 1173 hr of vessel survey and over 40 flights in summer to early fall (July to October) of five oil and gas prospects in the Chukchi Sea; ringed seals were over three times more often sighted than bearded seals, the next most common seal. These results suggest that ringed seal use is widespread in the sea ice but somewhat higher in nearshore that offshore ice during spring after which they use ice remnants during summer. Sea ice use depends on a variety of seasonal, environmental, and seal behavioral conditions, but appears to be relatively similar between the Chukchi and Beaufort Seas.

Ringed seals are a polygamous species. When sexually mature, they establish territories during the fall and maintain them during the pupping season. Pups are born in late March and April in lairs that seals excavate in snowdrifts and pressure ridges. During the breeding and pupping season, adults on shorefast ice (floating fast-ice zone) usually move less than individuals in other habitats; they depend on a relatively small number of holes and cracks in the ice for breathing and foraging. During nursing (4 to 6 weeks), pups usually stay in the birth lair. Alternate snow lairs provide physical and thermal protection when the pups are being pursued by their primary predator, polar bears and Arctic foxes (Smith et al. 1991 *cited in* USDI MMS 2003). The primary prey of ringed seals is Arctic cod, saffron cod, shrimps, amphipods, and euphausiids (Kelly 1988; and Reeves et al. 1992 *cited in* USDI MMS 2003). Ringed seals are a major resource that subsistence hunters harvest in Alaska (USDI MMS 2003).

Bearded Seals:

Bearded seals, the second most common seal in the arctic, are associated with sea ice and have a circumpolar distribution (Burns 1981). During the open-water period, bearded seals occur mainly in relatively shallow areas, because they are predominantly benthic feeders (Burns 1981). They prefer areas of water no deeper than 200 m (e.g., Harwood et al. 2005).

Bearded seals occur over the continental shelves of the Bering, Chukchi, and to a lesser extend the Beaufort Sea (Burns 1981). Early estimates of bearded seals in the Bering and Chukchi seas range from 250,000 to 300,000 (Popov 1976, Burns 1981). Reliable estimates of bearded seal abundance in Alaska waters are unavailable (Angliss and Outlaw 2005). The Alaska stock of bearded seals is not classified by NMFS as a strategic stock.

Seasonal movements of bearded seals are directly related to the advance and retreat of sea ice and to water depth (Kelly 1988). During winter, most bearded seals are in the Bering Sea. In the Chukchi and Beaufort seas, favorable conditions are more limited, and consequently, bearded seals are scarce there during winter. From mid-April to June, as the ice recedes, some of the bearded seals over-wintering in the Bering Sea migrate northward through the Bering Strait. During summer they occur near the widely fragmented margin of multi-year ice covering the continental shelf of the Chukchi Sea and in nearshore areas of the central and western Beaufort Sea. Brueggeman et al. (1990, 1991, 1992) recorded as many as 258 sightings of bearded seals west and southwest of Point Barrow during over 1173 hr of vessel survey and more than 40 flights in July to October of five oil and gas prospects in the Chukchi Sea.

In some areas, bearded seals are associated with the ice year-round; however, they usually move shoreward into open water areas when the pack ice retreats to areas with water depths >200 m. During summer, when the Bering Sea is ice-free, the most favorable bearded seal habitat is found in the central or northern Chukchi Sea along the margin of the pack ice. Suitable habitat is more limited in the Beaufort Sea where the continental shelf is narrower and the pack ice edge frequently occurs seaward of the shelf and over water too deep for benthic feeding.

Pupping takes place on top of the ice less than 1 meter from open water from late March through May mainly in the Bering and Chukchi seas, although some takes place in the Beaufort Sea (Kovacs et al. 1996 *cited in* MMS 2003). These seals do not form herds but sometimes do form loose groups. Bearded seals feed on a variety of primarily benthic prey, decapod crustaceans (crabs and shrimp) and mollusks (clams), and other food organisms, including Arctic and saffron cod, flounders, sculpins, and octopuses (Kelly 1988; and Reeves et al. 1992 *cited in* USDI MMS 2003).

Spotted Seal

Spotted seals (also known as largha seals) seasonally occur in the Beaufort, Chukchi, and Bering seas (Shaughnessy and Fay 1977). Spotted seals occur in large numbers along the Chukchi Sea coast from June to October (USDI MMS 1990) and in lower numbers along the Beaufort coast, hauling out on beaches, barrier islands, and remote sandbars on the river deltas (USDI MMS 2003). Haulouts within Kasegaluk Lagoon in the Chukchi Sea contain among the largest spotted seal concentrations in Alaska (Frost et al. 1993). Spotted seals migrate from the Chukchi or Beaufort Seas in the fall to the Being Sea where they winter.

A reliable estimate of spotted seals is currently not available. However, surveys conducted by Rugh et al. (1993) in the Bering Sea and at known haul out sites resulted in maximum counts of 4,145 in 1992 and 2,591 in 1993. Using the maximum count with a correction factor for missed seals, Angliss and Outlaw (2005) developed an estimate of 59,214 spotted seals. This represents a minimum estimate, since a substantial portion of their range was not included in the survey.

During spring when pupping, breeding, and molting occur, spotted seals are along the southern edge of the sea ice in the Bering Sea (Quakenbush 1988; Rugh et al. 1997). In late April and early May, adult spotted seals are often seen on the ice in female-pup or male-female pairs, or in male-female-pup triads. Subadults may be seen in larger groups of up to two hundred animals. During summer, spotted seals are primarily in the Bering and Chukchi seas, but some range into the Beaufort Sea (Rugh et al. 1997; Lowry et al. 1998) from July until September. At this time of year, spotted seals haul out on land part of the time, but also spend extended periods at sea. The seals are commonly seen in bays, lagoons and estuaries, but also range far offshore as far north as 69–72ºN. In summer, they are rarely seen on the pack ice, except when the ice is very near to shore. Brueggeman et al. (1990, 1991, 1992) recorded 50 or fewer sightings of spotted seals west and southwest of Point Barrow during over 1173 hr of vessel survey and more than 40 flights in summer to early fall (July to October) of five oil and gas prospects in the Chukchi Sea; considerably fewer spotted seals were observed than ringed or bearded seals. Spotted seals leave the Chukchi and Beaufort seas as ice cover thickens with the onset of winter and move into the Bering Sea (Lowry et al. 1998). Important prey includes pelagic fishes, octopus, and crustaceans.

5. The Type of Incidental Taking Authorization that is Being Requested (i.e., Takes By Harassment Only; Takes by Harassment, Injury and/or Death) and the Method of Incidental Taking.

CPAI is requesting authorization for incidental taking by harassment (Level B as defined in 50 CFR 216.3) of small numbers of marine mammals during its planned geophysical survey in the northeastern Chukchi Sea from July to late November depending on ice conditions. The operations outlined in § 1 and 2 have the potential to take marine mammals by harassment. Sounds will mainly be generated by the airguns used during the seismic survey, which is the focus of this request for an IHA. A supply helicopter, a supply vessel, fuel bunkering vessel, and general vessel operations are expected to generate substantially less noise than the airguns, and have no more than a negligible affect on the marine mammals for the following reasons. CPAI anticipates that the helicopter will fly directly to the vessel about once every 3-4 weeks (6-12 trips estimated during the seismic program) at an altitude (weather permitting) above where noise is know to *not* disturb marine mammals. Similarly, the supply vessel will make infrequent direct trips to the seismic vessel, and change course to avoid any marine mammals. General vessel noise from the seismic vessel will typically be masked by airgun operations.

“Takes” by harassment will potentially result when marine mammals near the seismic activities are exposed to the pulsed sounds generated by the airguns. The effects will depend on the species of cetacean or pinniped, the behavior of the animal at the time of reception of the stimulus, as well as the distance and received level of the sound (see § 7). Temporary disturbance reactions are likely amongst some of the marine mammals in the general vicinity of the tracklines of the source vessel. No take by serious injury is anticipated, given the nature of the planned operations and the planned mitigation measures (see § 11, “MITIGATION MEASURES”). No intentional or lethal takes are expected.

6. By Age, Sex, and Reproductive Condition (if Possible), the Number of Marine Mammals (By Species) that May be Taken by Each Type of Taking, and the Number of Times such Takings by Each Type of Taking are Likely to Occur.

All anticipated takes would be "takes by harassment", involving short term, temporary changes in behavior. The mitigation measures to be applied will minimize the possibility of injurious takes. However, there is no specific information demonstrating that injurious "takes" would occur even in the absence of the planned mitigation measures. In the sections below, we describe methods to estimate "take by harassment" and present estimates of the numbers of marine mammals that might be affected during the proposed seismic survey. The estimates are based on data obtained during marine mammal surveys in and near the Chukchi Sea by Bengston et al (2005), Moore et al. (2000a), and Brueggeman et al. (1990, 1991), and on estimates of the sizes of the areas where effects could potentially occur.

The estimated take of marine mammals is presented in Table 2 based on the density estimates in Table 1 and noise transmission loss estimates in Table 3. Disturbance was assumed to occur at and above the 160 dB level for all marine mammal species based on NOAA guidelines. Estimated distances at received levels were calculated using both the 16 and 24-airgun array; however, CPAI anticipates that over 90% of the survey will use the 16-airgun array. Ninety percent of the distance was calculated using the estimated distance for the received levels for the 16-gun array and 10% for the 24-gun array; the ratio CPAI anticipates using with the two array configurations. CPAI also anticipates the actual trackline shot will be 70% or less of the planned trackline because of weather and other factors causing unsuitable conditions for seismic surveys.

Table 1. Estimated density of marine mammals in the Chukchi Sea during 2006 seismic operations

Species	Average Density (#/km²)	Density used to calculate take (#/km²)	Source	Comment
Ringed Seal	1.76	0.53	Bengston et al (2005)	Density reduced by 70% to reflect distribution during seismic program
Bearded Seal	0.80	0.24	Brueggeman et al. (1990, 1991)	Density reduced 70% to reflect distribution during seismic program
Spotted Seal	0.0001	Same	U of A IHA application	
Bowhead Whale	0.0064	Same	U of A IHA application	
Gray Whale	0.0045	Same	U of A IHA application	
Beluga Whale	0.0034	Same	U of A IHA application	
Killer Whale	0.0000	NA		No est. available
Minke Whale	0.0000	NA		No est. available

Ringed seal density equals averaged density of ringed seals for 1999 (1.91/km²) and 2000 (1.62/km²) from Bengston et al. (2005).
Bearded seal density equals 45% of the average ringed seal density based on ratio of ringed to bearded seals observed by Brueggeman et al. (1990, 1991) in the northeastern Chukchi Sea during aerial and vessel surveys. Bengston et al (2005) estimated bearded seal density at 0.07/km² in 1999 and 0.14 /km² in 2000 in the Chukchi Sea, but was not able to adjust them for missed animals.
There are no reliable estimates for spotted seals or killer whales in the Chukchi Sea.

Table 2. Estimated take of marine mammals during 2006 seismic survey in the Chukchi Sea

Month	Track Planned (km)	Track Shot (km)	Bowhead	Gray	Beluga	Ringed	Bearded	Spotted
July	1609 \(1000 mi)	1126 (700 mi)	0	7	6	842	382	<1
Aug	4828 (3000 mi)	3380 (2100 mi)	0	21	16	2,526	1,144	<1
Sept	4828 (3000 mi)	3380 (2100 mi)	30	21	16	2,526	1,144	<1
Oct	4828 (3000 mi)	3380 (2100 mi)	30	21	16	2,526	1,144	<1
Nov	483 (300 mi)	338 (210 mi)	3	2	1	253	114	<1
Total			**63**	**72**	**55**	**8,673**	**3,928**	**100**

Take = (A) x (2B) x (C), where
A = km of track shot with the 16 gun and 24 gun arrays (Table 2)
B = transmission loss distance (km) to 160dB for the 16 and 24 gun arrays for all species (Table 3)
C = average density (Table 1).
CPAI estimates that actual trackline shot will be 70% of the planned trackline because of weather and other factors causing conditions not suitable for seismic surveys. 90% of the trackline would be shot with the 16 gun array and 10% with the 24 gun array.
Take Calculation Example: (3380 km x .90) x 1.4 km x 0.0064 (density) = 27 for the 16 gun array, and (3380 km x .10) x 1.5 km x 0.0064 = 3 for the 24 gun array resulting in a total take of 30 (27 + 3) bowhead whales for August.
Seal densities were reduced by half for calculating take since estimates are based on seals in the landfast and pack ice and not open water, where seals would be more widespread and at lower densities. Seismic operations will be primarily in open water south of the pack ice.

Density for each species of marine mammal in the project area was calculated from a variety of sources. Every attempt was made to use the most recent data specific to the Chukchi Sea, although some estimates included the western Alaska Beaufort Sea. Estimates for each species were adjusted for missed animals, and the densities were based on the following sources and calculations:

- Estimates for bowhead, gray, and beluga whale densities were obtained from surveys in the Chukchi and western Alaska Beaufort Sea by Moore et al (2000) as presented in the UAF IHA application.
- Estimates for ringed seal density were obtained from surveys in the Chukchi Sea by Bengston et al. (2005). The 1999 and 2000 density estimates were averaged to obtain one density value.

- Bearded seal density estimates were obtained by adjusting the density for ringed seals based on the ratio of bearded to ringed seals observed during surveys in the Chukchi Sea by Brueggeman et al. (1990, 1991). While Bengston et al. (2005) calculated bearded seal density in the Chukchi Sea for 1999 and 2000, the data were not suitable for correcting for missed animals, and subsets of the data were not appropriate for developing a ratio of bearded to ringed seals to derive a density based on a ratio. Both the bearded and ringed seal density estimates are likely high, since Bengston et al. (2005) surveys included an area south of the project area, where they reported ringed and bearded seal densities were considerably higher than north of Point Hope, which corresponds to the seismic project area.
- Spotted seal estimates were obtained from estimates in the U of A IHA application, since there are no reliable density estimates for this species in the Chukchi Sea. Most spotted seals summer near the coast, therefore, densities would be expected to be quite low in most of the project area. Since the estimated take in Table 2 is less than one per month, we have arbitrarily estimated that no more than 100 spotted seals would be taken by harassment during the seismic operations to account for unexpected contact with more spotted seals than provided by the density estimate.
- No density estimate was calculated for killer or minke whales, since they are very uncommon in the project area.

Take was calculated for each month of the seismic survey period to account for seasonal use patterns by the marine mammals in the project area. All species are expected to be present in the project area during each month of the seismic survey except for the bowhead whale. Bowhead whales are normally present in the project area during the fall migration in September, October, and November, when they migrate across the Chukchi Sea on their return to the Bering Sea wintering grounds. Consequently, take was only calculated for these months. Belugas will be in the project area throughout the seismic survey period, but most will be in the coastal bays and lagoons or in the Beaufort Sea during the open water months. While the estimated take was not adjusted downward to account for this fact, the take may be considerably less than estimated for beluga whales. Lastly, the density values for ringed and bearded seals were reduced by 70% for calculating take, since estimates are based on seals in the landfast and pack ice, and not open water, where the planned seismic surveys will occur and seals are more widespread and at lower densities. In addition, seals hauled out on the pack ice will not be exposed to seismic sounds, further reducing the actual take for ringed and bearded seals. For these and other reasons CPAI believes the estimated take is quite conservative.

Take was not calculated for the eco-sounder, acoustic positioning system, and current meter on the seismic vessel, since their influence on marine mammals is less than for the airgun configurations. It is assumed that, during simultaneous operations of those additional sound sources and the airgun(s), any marine mammals close enough to be affected by the eco-sounder, acoustic positioning system, and current meter would already be affected by the airgun(s). However, whether or not the airgun(s) is operating simultaneously with the other sound sources, marine mammals are expected to exhibit no more than short-term and inconsequential responses to them given their characteristics (e.g., narrow downward-directed beam, very high frequency, low power) and other considerations described in this document. Such reactions are not considered to constitute "taking" (NMFS 2001). Therefore, no additional allowance is included for animals that might be affected by the sound sources other than the airgun(s).

7. The Anticipated Impact of the Activity on the Species or Stock

This section includes a description of the impact of seismic activities on marine mammals.

Potential Effects of Airgun Sounds.

The effects of sounds from airguns on marine mammals might include one or more of the following: tolerance, masking of natural sounds, behavioral disturbance, and at least in theory, temporary or permanent hearing impairment, or non-auditory physical effects (Richardson et al. 1995). Because of the mitigation procedures it is unlikely there would be any temporary or especially permanent hearing impairment, or non-auditory physical effects. Also, behavioral disturbance is expected to be short term and limited to relatively short distances from the noise source.

Tolerance

Studies have shown that pulsed sounds from airguns are often readily detectable in the water at distances of many kilometers. Numerous studies have shown that marine mammals at distances over a few kilometers from operating seismic vessels often show no apparent response. That is often true even when pulsed sounds must be readily audible to the animals based on measured received levels and the hearing sensitivity of that mammal group. Although various baleen whales, toothed whales, and (less frequently) pinnipeds have been shown to react behaviorally to airgun pulses under some conditions, at other times they have shown no overt reactions. In general, pinnipeds and small odontocetes seem more tolerant of exposure to airgun pulses than baleen whales.

Masking

Masking of marine mammal calls and other natural sounds are expected to be limited, although there are very few specific data of relevance. Some whales are known to continue calling in the presence of seismic pulses. Their calls can be heard between seismic pulses (e.g., Richardson et al. 1986; McDonald et al. 1995; Greene et al. 1999; Nieukirk et al. 2004). Masking effects of seismic pulses are expected to be negligible in the case of the smaller odontocete cetaceans, given the intermittent nature of seismic pulses. Also, the sounds important to small odontocetes are predominantly at much higher frequencies than are airgun sounds.

Disturbance Reactions

Disturbance includes a variety of effects, including subtle changes in behavior, more conspicuous changes in activities, and displacement. Based on NMFS (2001, p. 9293), we assume that simple exposure to sound, or brief reactions that do not disrupt behavioral patterns in a potentially significant manner, do not constitute harassment or "taking". By potentially significant, we mean "in a manner that might have deleterious effects to the well-being of individual marine mammals or their populations".

Reactions to sound, if any, depend on species, state of maturity, experience, current activity, reproductive state, time of day, and many other factors. If a marine mammal does react briefly to an underwater sound by changing its behavior or moving a short distance, the impacts of the change are unlikely to be significant to the individual, let alone the stock or the species as a whole. However, if a sound source displaces marine mammals from an important feeding or breeding area for a prolonged period, impacts on the animals could be significant. Given the many uncertainties in predicting the quantity and types of impacts of noise on marine mammals, it is common practice to estimate how many mammals were present within a particular distance of industrial activities, or exposed to a particular level of industrial sound. That likely overestimates the numbers of marine mammals that are affected in some biologically important manner.

The sound criteria used to estimate how many marine mammals might be disturbed to some biologically important degree by a seismic program are based on behavioral observations during studies of several species. However, information is lacking for many species. Detailed studies have been done on gray, bowhead whales, and ringed seals.

Baleen Whales. — Baleen whales generally avoid operating airguns, but avoidance radii are quite variable (Malme et al. 1984, 1985, 1988; Richardson et al. 1986, 1995, 1999; Ljungblad et al. 1988; Richardson and Malme 1993; McCauley et al. 1998, 2000a; Miller et al. 1999; Gordon et al. 2004). Whales often show no overt reactions to pulses from large arrays of airguns at distances beyond a few kilometers, even when airgun pulses remain well above ambient noise levels for longer distances. However, baleen whales exposed to strong noise pulses from airguns often react by deviating from their normal migration route around the sound source and/or interrupting their feeding and moving away. However, the observed changes in behavior of migrating bowhead and gray whales appeared to be of little or no biological consequence to the animals. They simply avoided the sound source by adjusting their track within the natural boundaries of the migration corridors.

Studies of gray and bowhead whales have shown received levels of pulses in the 160–170 dB re 1 µPa rms range seem to cause obvious avoidance behavior in a substantial fraction of the animals exposed. Seismic pulses from large airgun arrays often diminish to those levels out to distances ranging from 4.5 to 14.5 km from the source. Bowhead whales on their summering grounds in the Canadian Beaufort Sea showed no obvious reactions to pulses from seismic vessels at distances of 6 to 99 km (3–53 nm.) and received sound levels of 107–158 dB on an approximate rms basis (Richardson et al. 1986); their general activities were indistinguishable from those of a control group. However, subtle but statistically significant changes in surfacing–respiration–dive cycles were evident upon statistical analysis. Bowheads usually did show strong avoidance responses when seismic vessels approached within a few kilometers (~3–7 km or 1.6–3.8 n.mi.) and when received levels of airgun sounds were 152–178 dB (Richardson et al. 1986, 1995; Ljungblad et al. 1988). In one case, bowheads engaged in near-bottom feeding began to turn away from a 30-airgun array with a source level of 248 dB re 1 µPa · m at a distance of 7.5 km (4 n.mi.), and swam away when it came within about 2 km (1.1 n.mi.). Some whales continued feeding until the vessel was 3 km (1.6 n.mi.) away. This work and a more recent study by Miller et al. (2005), show that feeding bowhead whales tend to tolerate higher sound levels than migrating whales before showing an overt change in behavior. The feeding whales may be affected by the sounds, but the need to feed may reduce the tendency to move away.

Bowhead whales migrating west across the Alaskan Beaufort Sea in autumn, in particular, showed avoidance out to distances of 20–30 km from a medium-sized airgun source (Miller et al. 1999; Richardson et al. 1999). In 1996–98, a partially-controlled study of the effect of Ocean Bottom Cable (OBC) seismic surveys on westward-migrating bowheads was conducted in late summer and autumn in the Alaskan Beaufort Sea (Miller et al. 1999; Richardson et al. 1999). Aerial surveys showed that some westward-migrating whales avoided an active seismic survey boat by 20–30 km (10.8–16.2 n.mi.), and that few bowheads approached within 20 km (10.8 n.mi.). Received sound levels at those distances were only 116–135 dB re 1 µPa (rms). Some whales apparently began to deflect their migration path when as much as 35 km (19 n.mi.) away from the airguns. At times when the airguns were not active, many bowheads moved into the area close to the inactive seismic vessel. Avoidance of the area of seismic operations did not persist beyond 12–24 h after seismic shooting stopped. These and other data suggest that migrating bowhead whales are more responsive to seismic pulses than were summering bowheads.

Malme et al. (1986, 1988) found that 50% of a group of gray whales ceased feeding at an average received pressure level of 173 dB re 1 µPa on an (approximate) rms basis to pulses from a single 100 in^3 airgun off St. Lawrence Island in the northern Bering Sea. In addition, 10% of whales interrupted feeding at received levels of 163 dB. Malme at al. (1986) estimated that an average pressure level of 173 dB occurred at a range of 2.6 to 2.8 km (1.4–1.5 n.mi.) from an airgun array with a source level of 250 dB (0-pk) in the northern Bering Sea. There was no indication that western gray whales exposed to seismic noise were displaced from their overall feeding grounds near Sakhalin Island during seismic programs in 1997 (Würsig et al. 1999) and in 2001. However, there were indications of subtle behavioral effects and (in 2001) localized avoidance by some individuals (Johnson 2002; Weller et al. 2002).

Experiments were conducted on larger numbers of gray whales migrating along the California coast. Malme and Miles (1985) concluded that, during migration, changes in swimming pattern occurred for received levels of about 160 dB re 1 µPa and higher, on an approximate rms basis. The 50% probability of avoidance was estimated to occur at a closest point of approach distance of 2.5 km (1.3 n.mi.) from a 4000-in³ array operating off central California. This would occur at an average received sound level of about 170 dB (rms). Some slight behavioral changes were noted at received sound levels of 140 to 160 dB (rms).

Data on short-term reactions (or lack of reactions) of cetaceans to impulsive noises do not necessarily provide information about long-term effects. It is not known whether impulsive noises affect reproductive rate or distribution and habitat use in subsequent days or years. However, gray whales continue to migrate annually along the west coast of North America with amazing regularity despite intermittent seismic exploration and ever increasing ship traffic (Malme et al. 1984). Bowhead whales continue to travel to the eastern Beaufort Sea each summer despite seismic exploration in their summer and autumn range for many years (Richardson et al. 1987). Populations of both gray and bowhead whales grew substantially during this time to the point where gray whales are at or near carrying capacity and bowheads are approaching carrying capacity.

Toothed Whales. Little systematic information is available about reactions of beluga and killer whales to noise pulses. Beluga whales exhibit changes in behavior when exposed to strong, pulsed sounds similar in duration to those typically used in seismic surveys (Finneran et al. 2000, 2002). However, the animals tolerated high received levels of sound (pk–pk level >200 dB re 1 µPa) before exhibiting aversive behaviors. Belugas summering in the Eastern Beaufort Sea may have avoided the area of seismic operations (2 arrays with 24 airguns per array) by 10-20 km, although belugas occurred as close as 1540 m to the line seismic operations (Miller et al 2005). Observers stationed on seismic vessels operating off the United Kingdom from 1997–2000 have provided data on the occurrence and behavior of various toothed whales exposed to seismic pulses (Stone 2003; Gordon et al. 2004). Killer whales were found to be significantly farther from large airgun arrays during periods of shooting compared with periods of no shooting. The displacement of the median distance from the array was ~0.5 km (0.3 n.mi.) or more. Killer whales also appear to be more tolerant of seismic shooting in deeper water.

Pinnipeds. Monitoring studies in the Alaskan and Canadian Beaufort Sea during 1996–2002 provided considerable information regarding behavior of seals exposed to seismic pulses **(**Miller et al. 2005; Harris et al. 2001; Moulton and Lawson 2002). These seismic projects usually involved arrays of 6 to 16 with as many as 24 airguns with total volumes 560 to 1500 in3. The combined results suggest that some seals avoid the immediate area around seismic vessels. In most survey years, ringed seal sightings tended to be farther away from the seismic vessel when the airguns were operating then when they were not (Moulton and Lawson 2002). However, these avoidance movements were relatively small, on the order of 100 m (328 ft) to (at most) a few hundred meters, and many seals remained within 100–200 m (328–656 ft) of the trackline as the operating airgun array passed by. Seal sighting rates at the water surface were lower during airgun array operations than during no-airgun periods in each survey year except 1997. Miller et al (2005) also reported higher sighting rates during non-seismic than during line seismic operations, but there was no difference for mean sighting distances during the two conditions nor was there evidence ringed or bearded seals were displaced from the area by the operations.

The operation of the airgun array had minor and variable effects on the behavior of seals visible at the surface within a few hundred meters of the array. The behavioral data from these studies indicated that some seals were more likely to swim away from the source vessel during periods of airgun operations and more likely to swim towards or parallel to the vessel during non-seismic periods. No consistent relationship was observed between exposure to airgun noise and proportions of seals engaged in other recognizable behaviors, e.g. “looked” and “dove”. Such a relationship might have occurred if seals seek to reduce exposure to strong seismic pulses, given the reduced airgun noise levels close to the surface where “looking” occurs (Miller et al. 2005; Moulton and Lawson 2002).

Consequently, bearded, ringed, and probably spotted seals (least amount of data on reaction to seismic operations) are not likely to show a strong avoidance reaction to the proposed airgun sources. Pinnipeds frequently do not avoid the area within a few hundred meters of operating airgun arrays, even for large airgun arrays (e.g**.,** Harris et al. 2001). Reactions are expected very localized and confined to relatively small distances and durations, with no long-term effects on individuals or populations.

Hearing Impairment and Other Physical Effects

Temporary or permanent hearing impairment is possible when marine mammals are exposed to very strong sounds, but there has been no specific documentation of this for marine mammals exposed to sequences of airgun pulses. Current NMFS policy regarding exposure of marine mammals to high-level sounds is that cetaceans and pinnipeds should not be exposed to impulsive sounds =180 and 190 dB re 1 µPa (rms), respectively (NMFS 2000). Those criteria have been used in defining the safety (=shutdown) radii planned for the proposed seismic survey.

However, those criteria were established before there were any data on the minimum received levels of sounds necessary to cause temporary auditory impairment in marine mammals. As summarized below

•The 180-dB criterion for cetaceans is probably quite precautionary, i.e., lower than necessary to avoid temporary threshold shift (TTS), let alone permanent auditory injury.

• The minimum sound level necessary to cause permanent hearing impairment is higher, by a variable and generally unknown amount, than the level that induces barely-detectable TTS.

•The level associated with the onset of TTS is often considered to be a level below which there is no danger of permanent damage.

NMFS is presently developing new noise exposure criteria for marine mammals that take account of the now-available data on TTS and other relevant factors in marine and terrestrial mammals (NMFS 2005; D. Wieting in ttp://mmc.gov/sound/plenary2/pdf/plenary2summaryfinal.pdf**).**

Because of the planned monitoring and mitigation measures, there is little likelihood any marine mammals will be exposed to sounds sufficiently strong to cause even the mildest (and reversible) form of hearing impairment. Several aspects of the planned monitoring and mitigation measures for this project are designed to detect marine mammals occurring near the airgun(s), and to avoid exposing them to sound pulses that might (at least in theory) cause hearing impairment [see § XI, "MITIGATION MEASURES"]. In addition, many cetaceans are likely to show some avoidance of the small area with high received levels of airgun sound. In those cases, the avoidance responses of the animals themselves will reduce or (most likely) avoid any possibility of hearing impairment.

Temporary Threshold Shift (TTS) TTS is the mildest form of hearing impairment that can occur during exposure to a strong sound (Kryter 1985). While experiencing TTS, the hearing threshold rises and a sound must be stronger in order to be heard. TTS can last from minutes or hours to (in cases of strong TTS) days. For sound exposures at or somewhat above the TTS threshold, hearing sensitivity recovers rapidly after exposure to the noise ends. There is limited data on sound levels and durations necessary to elicit mild TTS for marine mammals**,** and <u>none</u> of the published data concern TTS elicited by exposure to multiple pulses of sound.

For toothed whales (beluga, killer whales, etc.) exposed to single short pulses, the TTS threshold appears to be, at first approximation, a function of the energy content of the pulse (Finneran et al. 2002). Given the available data, the received level of a single seismic pulse might need to be ~210 dB re 1 µPa rms (~221-226 dB pk-pk) in order to produce brief, mild TTS. Exposure to several seismic pulses at received levels near 200-205 dB (rms) might result in slight TTS in a small odontocete (e.g., beluga whale), assuming the TTS threshold is (to a first approximation) a function of the total received pulse energy. Seismic pulses with received levels of 200-205 dB or more are usually restricted to a radius of no more than 100 m around a seismic vessel operating a large array of airguns. For baleen whales, there are no data, direct or indirect, on levels or properties of sound that are required to induce TTS. However, no cases of TTS are expected given the strong likelihood that baleen whales (e.g., bowhead/gray) would avoid the approaching airgun(s), or vessel, before being exposed to levels high enough for any possibility of TTS.

In pinnipeds (e.g., ringed, bearded, spotted seals), TTS thresholds associated with exposure to brief pulses (single or multiple) of underwater sound have not been measured. Initial evidence from prolonged exposures suggested that some pinnipeds may incur TTS at somewhat lower received levels than do small odontocetes exposed for similar durations (Kastak et al. 1999**;** Ketten et al. 2001**;** cf. Au et al. 2000**).** However, more recent indications are that TTS onset in the most sensitive pinniped species studied (harbor seal, which don't occur in project area) may occur at a similar sound exposure level as in odontocetes (Kastak et al. 2004).

A marine mammal within a radius of =100 m (=328 ft) around a typical large array of operating airguns might be exposed to a few seismic pulses with levels of =205 dB, and possibly more pulses if the mammal moved with the seismic vessel. (As noted above, most cetacean species tend to avoid operating airguns, although not all individuals do so.) However, several of the considerations that are relevant in assessing the impact of typical seismic surveys with arrays of airguns are not directly applicable here:

- "Ramping up" (soft start) is standard operational protocol during startup of large airgun arrays. Ramping up involves starting the airguns in sequence, usually commencing with a single airgun and gradually adding additional airguns, giving a marine mammal time to distance itself from the noise source.

- Even with a large airgun array, it is unlikely that cetaceans would be exposed to airgun pulses at a sufficiently high level for a sufficiently long period to cause more than mild TTS, given the relative movement of the vessel and the marine mammal.

- With a large array of airguns, TTS would be most likely in any odontocetes that linger near the active airguns, which would be unusual and not expected based on their behavior. In the present project, the anticipated 180 dB distances are 250 and 300 m for the 16 and 24 gun systems, respectively.

NMFS (1995, 2000) concluded that cetaceans and pinnipeds should not be exposed to pulsed underwater noise at received levels exceeding, respectively, 180 and 190 dB re 1 µPa (rms). The 180 and 190 dB distances for the airguns operated by CPAI are estimated to be 250 and 150m for the 16-gun array and 300 and 250m for the 24-gun array, respectively (Table 3). These sound levels are not considered to be high enough levels to cause TTS. Rather, they are the received levels above which, in the view of a panel of bioacoustics specialists convened by NMFS before TTS measurements for marine mammals started to become available, one could not be certain that there would be no injurious effects, auditory or otherwise, to marine mammals. TTS data that are now available imply that, at least for dolphins (none occur in project area), TTS is unlikely to occur unless the dolphins are exposed to airgun pulses much stronger than 180 dB re 1 µPa rms.

Permanent Threshold Shift (PTS) When PTS occurs, there is physical damage to the sound receptors in the ear. In some cases, there can be total or partial deafness, whereas in other cases, the animal has an impaired ability to hear sounds in specific frequency ranges.

There is no specific evidence that exposure to pulses of airgun sound can cause PTS in any marine mammal, even with large arrays of airguns. However, given the possibility that mammals close to an airgun array might incur TTS, there has been further speculation about the possibility that some individuals occurring very close to airguns might incur PTS. Single or occasional occurrences of mild TTS are not indicative of permanent auditory damage in terrestrial mammals. Relationships between TTS and PTS thresholds have not been studied in marine mammals, but are assumed to be similar to those in humans and other terrestrial mammals. PTS might occur at a received sound level 20 dB or more above that inducing mild TTS if the animal were exposed to the strong sound for an extended period, or to a strong sound with very rapid rise time.

In the proposed project, marine mammals are unlikely to be exposed to received levels of seismic pulses strong enough to cause TTS, unless they are within several meters of an airgun. Given the higher level of sound necessary to cause PTS, it is even less likely that PTS could occur. Baleen whales generally avoid the immediate area around operating seismic vessels. The planned monitoring and mitigation measures, including visual monitoring power downs and shut downs of the airguns when mammals are seen within the "safety radii", will minimize the already-minimal probability of exposure of marine mammals to sounds strong enough to induce PTS.

Non-auditory Physiological Effects Non-auditory physiological effects or injuries that theoretically might occur in marine mammals exposed to strong underwater sound include stress, neurological effects, bubble formation, resonance effects, and other types of organ or tissue damage. *There is no proof* *that any of these effects occur in marine mammals exposed to sound from airgun arrays.* However, there have been no direct studies of the potential for airgun pulses to elicit any of those effects. If any such effects do occur, they probably would be limited to unusual situations when animals might be exposed at close range for unusually long periods. It is doubtful that any single marine mammal would be exposed to strong seismic sounds for sufficiently long that significant physiological stress would develop.

Gas-filled structures in marine animals have an inherent fundamental resonance frequency. If stimulated at that frequency, the ensuing resonance could cause damage to the animal. A workshop (Gentry [ed.] 2002) was held to discuss whether the stranding of beaked whales in the Bahamas in 2000, which don't occur in the project area (Balcomb and Claridge 2001; NOAA and USN 2001) might have been related to air cavity resonance or bubble formation in tissues caused by exposure to noise from naval sonar not seismic operations. A panel of experts concluded that resonance in air-filled structures was not likely to have caused the stranding. Opinions were less conclusive about the possible role of gas (nitrogen) bubble formation/growth in the Bahamas stranding of beaked whales.

Until recently, it was assumed that diving marine mammals are not subject to the bends or air embolisms. However, a recent article documents the probability of the bends manifested in sperm whale skeletons, which is a species that doesn't occur in the project area (Moore and Early 2004). Skeletal pitting and erosion, hypothesized to be the result of nitrogen emboli, was discovered in 16 sperm whale skeletons spanning a period of 111 years. Larger sperm whale skeletons exhibited the most damage, indicating a chronic pathology. Another short paper concerning beaked whales stranded in the Canary Islands in 2002 suggests that cetaceans might be subject to decompression injury in some situations (Jepson et al. 2003). If so, that might occur if they ascend unusually quickly when exposed to aversive sounds. However, the interpretation that the effect was related to decompression injury is unproven (Piantadosi and Thalmann 2004; Fernández et al. 2004). Even if that effect can occur during exposure to mid-frequency sonar, *there is no evidence that that type of effect occurs in response to airgun sounds.*

In general, little is known about the potential for seismic survey sounds to cause auditory impairment or other physical effects in marine mammals. The available data do not allow for meaningful quantitative predictions of the numbers (if any) of marine mammals that might be affected in those ways. Marine mammals that show behavioral avoidance of seismic vessels, including most baleen whales, some odontocetes, and some pinnipeds, are especially unlikely to incur auditory impairment or other physical effects. Also, the planned monitoring and mitigation measures include shut downs of the airguns, which will reduce any such effects that might otherwise occur.

Strandings and Mortality

There is no proof that airgun pulses can cause serious injury, death, or stranding even in the case of large airgun arrays. While strandings have been associated with military mid frequency sonar pulses, CPAI does not plan to use any sonar systems during the 2006 seismic program other than standard ship equipment for navigation which operate at very low power and high frequency (55-200kHz). Seismic pulses and military mid-frequency sonar pulses are quite different. Sounds produced by airgun arrays are broadband with most of the energy below 1 kHz. Typical military mid-frequency sonars operate at frequencies of 2-10 kHz, generally with a relatively narrow bandwidth at any one time. Thus, it is not appropriate to assume that there is a direct connection between the effects of military sonar and seismic surveys on marine mammals.

NMFS (2001) has concluded that momentary behavioral reactions "do not rise to the level of taking". Thus, brief exposure of cetaceans or pinnipeds to small numbers of signals from the sonar systems to be used on the proposed project would not result in a "take" by harassment.

8. The Anticipated Impact of the Activity on the Availability of the Species or Stocks of Marine Mammals for Subsistence Uses

Marine mammals are key in the subsistence economies of the communities bordering the project area, including Barrow, Wainwright, Point Lay, and Point Hope. Other communities that subsist on marine mammals are considerably beyond the project area, and their subsistence activities are unlikely to be affected by the seismic operations in the Chukchi Sea. The whale harvests have a great influence on social relations by strengthening the sense of Inupiat culture and heritage in addition to reinforcing family and community ties

Bowhead whales are important for subsistence at all of the villages bordering the project area except Point Lay, which does not hunt bowhead whales. The harvest is based on a quota, established by the IWC and regulated by agreement between AEWC and NMFS, according to the cultural and nutritional needs of Alaska Eskimos as well as on estimates of the size and growth of the stock of bowhead whales (Suydam and George 2004). In 2002 the IWC set a five-year block quota of 67 strikes per year with a total landed not to exceed 280 whales (IWC 2003). The most recent data show the 37, 35, and 36 whales were landed in 2000-2004 for a total of 108 whales (Suydam and George 2004, Suydam et al. 2005). Between 23 and 28 were taken at Point Hope, Wainwright, and Barrow during these years, with most (60-90%) taken by Barrow each year.

Bowheads are hunted during the spring and fall migrations. Point Hope and Wainwright only hunt during the spring migration where as Barrow hunts during the spring and fall migrations. Barrow takes most bowheads during the spring migration (Table 1). The spring bowhead hunt occurs after leads open due to the deterioration of pack ice, which typically occurs from early April until the first week of June. Because of the timing, Point Hope, Wainwright, and Barrow should not be affected by seismic operation, since the hunt should be completed before the start of seismic operations in July.

Table 1. Number of whales landed during the spring/fall at Barrow, 1995-2004

Yr	**95**	**96**	**97**	**98**	**99**	**00**	**01**	**02**	**03**	**04**	**05**
No	19/11	24/19	30/21	25/16	24/6	18/13	27/7	22/17	16/6	6/13	N/A

Source; Suydam and George, 2004 and Suydam et al. 2005.

The autumn hunt at Barrow usually begins in mid-September, and mainly occurs in the waters east and northeast of Point Barrow in the Beaufort Sea. The whales have usually left the Beaufort Sea by late October (Treacy 2002a,b). The location of the fall hunt depends on ice conditions, which can influence distance of whales from shore (Brower 1996). Hunters prefer to take bowheads close to shore to avoid a long tow during which the meat can spoil, but Braund and Moorehead (1995) report that crews may (rarely) pursue whales as far as 80 km, and in 2004 hunters harvested a whale up to 50 km northeast of Barrow (Suydam et al. 2005). The fall hunt should not be affected by seismic operations, since it typically occurs a considerable distance east of the project area, and the whales pass Barrow from the east before entering the Chukchi Sea. Some whales are reported off Barrow in summer between migrations but subsistence at Barrow should not be affected by seismic operations since the location of the hunt is a considerable distance from the project area (Craig George, personal communications).

Beluga whales are hunted for subsistence at Barrow, Wainwright, Point Lay, and Point Hope, with the most taken by Point Lay (Fuller and George 1997). Point Lay harvests belugas primarily during summer in Kasegaluk Lagoon, where they averaged 40 belugas per year over a 10-year period (Fuller and George 1997). Compared to Point Lay, small numbers of belugas are harvested by Barrow with intermediate numbers harvested by Point Hope and Wainwright. Harvest at these villages generally occurs between April and July with most taken in April and May when pack-ice conditions deteriorate and leads open up. Hunters usually wait until after the bowhead whale hunt to hunt belugas. The Alaska Beluga Whale Committee recorded 23 beluga whales harvested by Barrow hunters from 1987 to 2002, ranging from 0 in 1987, 1988 and 1995 to the high of 8 in 1997 (Fuller and George 1999; Alaska Beluga Whale Committee 2002 in USDI/BLM 2005). The time of the project will not overlap hunts at Point Hope, Wainwright, and Barrow, and Point Hope and Barrow should be largely beyond any influence of the project activities. Point Lay villagers hunt in Kasegaluk Lagoon, which is beyond the influence of the project activities. Furthermore, the lagoon is shallow and close to shore, which would greatly reduces any underwater seismic noise, in the unlikely event some reached the lagoon.

Ringed, bearded, and spotted seals are hunted by all of the villages bordering the project area (Fuller and George 1997). Ringed seals comprise the largest part of the subsistence hunt and spotted seal the least, particularly at Barrow where they are primarily hunted near shore. Spotted seals are considerably more abundant in the Chukchi than Beaufort Sea. At Barrow, spotted seals are primarily hunted in Admiralty Bay, which is about 60 km east of Barrow. The largest concentrations of spotted seals in Alaska are in Kasegaluk Lagoon, where Point Lay hunters harvest them. (Frost et al. 1993). Braund et al. (1993) found that the majority of bearded seals taken by Barrow hunters are within ~24 km off shore. Ringed and bearded seals are hunted throughout the year, but most are taken in May, June, and July when ice breaks up and there is open water instead of the more difficult hunting of seals at holes and lairs. The timing slightly varies among villages, with peak hunting occurring incrementally later going from Point Hope to Barrow. Spotted seals are only hunted in spring through summer, since they winter in the Bering Sea. The seismic operation should have little to no affect on subsistence hunting since the seismic survey will no more than minimally overlap the end of primary period when seals are harvested, and most hunting at the villages will be a considerable distance away from seismic operations, particularly at Point Hope (74 km) and Point Lay (90 km).

The scheduling of this seismic survey will be discussed with representatives of those concerned with the subsistence hunt, most notably the Alaska Eskimo Whaling Captains (AEWC), the Barrow Whaling Captains' Association (BWCA), and the North Slope Borough Dept of Wildlife Management. While the location and timing of seismic operation should have no to no more than a negligible effect on subsistence at any of the villages, additional measures will be implemented to schedule seismic surveys in areas away from the villages during prime hunting periods, whenever possible. CPAI will work with and implement a Conflict Avoidance Agreement with the local whaling entities to outline how concerns will be addressed.

9. The Anticipated Impact of the Activity upon the Habitat of the Marine Mammal Populations, and the Likelihood of Restoration of the Affected Habitat.

The proposed seismic survey will not cause any permanent impact on habitats and the prey used by marine mammals as described in earlier responses and restated below regarding prey.

There is a relative lack of knowledge about the potential physical (pathological and physiological) effects of seismic energy on marine fish and invertebrates. Available data suggest that there may be physical impacts on eggs and on, larval, juvenile, and adult stages at very close range to seismic energy sources. Considering typical source levels associated with seismic arrays, close proximity to the source would result in exposure to very high energy levels. Whereas egg and larval stages are not able to escape such exposures, juveniles and adults most likely would avoid them. In the cases of eggs and larvae, it is likely that the numbers adversely affected by such exposure would be small in relation to natural mortality. Limited data regarding physiological impacts on fish and invertebrates indicate that these impacts are short-term and are most apparent after exposure at very close range (McCauley et al. 2000a,b**,** Dalen et al. 1996).

As in the case with physical effects of seismic on fish and invertebrates, available information on behavioral effects is relatively scant and often contradictory. There have been well-documented observations of fish and invertebrates exhibiting behaviors that appeared to be responses to exposure to seismic energy (i.e., startle response, change in swimming direction and speed, and change in vertical distribution (Wardle et al. 2001, Pearson et al. 1992). Some studies indicate that such behavioral changes are very temporary, whereas others imply that fish might not resume pre-seismic behaviors or distributions for a number of days (Engås et al. (1996). The type of behavioral reaction (startle, alarm, and avoidance) appears to depend on many factors, including the type of behavior being exhibited before exposure, and proximity and energy level of the sound source. The ultimate importance of those behaviors is unclear, but they do appear to be local and temporary.

Only a small fraction of the available habitat would be impacted by noise at any given time during the seismic surveys, and the constant movement of the seismic vessel would prevent any area from sustaining high noise levels for extended periods of time. Disturbance to fish species would be short-term and temporary, returning to their pre-disturbance behavior once the seismic activity ceases. Similarly, concentrations of zooplankton consumed by bowheads would only respond to a seismic impulse very close to the source, where they may scatter before regrouping after the seismic vessel passes. Thus, the proposed activity is not expected to have any effects on habitat or prey that could cause permanent or long-term consequences for individual marine mammals or their populations, since operations at the various sites will be limited in duration, location, timing, and intensity.

10. The Anticipated Impact of the Loss or Modification of the Habitat on the Marine Mammal Populations Involved.

The proposed seismic survey will not result in any permanent impact on habitats used by marine mammals, or to the food sources they utilize. The main issues are direct and indirect impacts to habitat. Direct impacts are physical destruction or alteration of habitat, which will not occur from the seismic surveys. Indirect impacts are primarily caused by ensonification of habitat from noise, which will be localized and short term, since the proposed seismic surveys will be of short duration in any particular area at any given time. Ensonification from seismic operations should have no more than a negligible effect on marine mammal habitat because:

- The seismic vessel will be constantly moving thereby preventing any given area from sustaining a constant level of noise.

- No studies have demonstrated that seismic noise affects the life stages, condition, or amount of food resources (fish, invertebrates, eggs) comprising habitats used by marine mammals, except when exposed to within a few meters of the seismic source or in a few very isolated cases. Where fish or invertebrates did respond to seismic noise, the affects were of temporary and of short duration (See above). Consequently, disturbance to fish species would be short-term and fish would return to their pre-disturbance behavior once the seismic activity ceases. Thus, the proposed survey would have little, if any, impact on the abilities of marine mammals to feed in the area where seismic work is planned.
- Migrating bowhead whales may feed in the Chukchi Sea during the fall (October/November). They feed on concentrations of zooplankon. A reaction by zooplankton to a seismic impulse would only be relevant to whales if it caused a concentration of zooplankton to scatter. Pressure changes of sufficient magnitude to cause that type of reaction would probably occur only very close to the source. Impacts on zooplankton behavior are predicted to be negligible, and that would translate into negligible impacts on feeding bowhead whales.
- The seismic area covers a small percentage of the available habitat used by marine mammals in the Chukchi Sea allowing them to move away from any noise to feed, rest, or migrate.

Thus, the proposed activity is not expected to have any habitat-related effects that could cause significant or long-term consequences for individual marine mammals or their populations, since operations at the various sites will be limited in duration.

11. Mitigation Measures (The Availability and Feasibility (Economic and Technological) of Equipment, Methods, and Manner of Conducting Such Activity or means of Effecting the Least Practicable Adverse Impact upon the Affected Species or Stocks, Their Habitat, and on Their Availability for Subsistence Uses, Paying Particular Attention to Rookeries, Mating Grounds, and Areas of Similar Significance).

CPAI's seismic operations will deploy airgun sources involving 16 or 24 airguns. Over 90% of the operations is expected to use a 16-gun array.

Gray whales will be feeding in the Chukchi Sea during July, August, September, and October, as will also migrating bowheads during late September and October, and other marine mammals throughout the survey period. However, the number of individual animals expected to be closely approached during the proposed activity will be small relative to their population sizes. With the proposed monitoring, ramp-up, power-down, and shut-down provisions described below, seismic surveys area expected to be no more than negligible impacts on the species and stocks.

Marine Mammal Monitoring

Vessel-based observers will monitor marine mammals near the seismic source vessel during all daytime airgun operations and during any nighttime startups of the airguns. These observations will provide the real-time data needed to implement some of the key mitigation measures. When marine mammals are observed within, or about to enter, designated safety zones (see below) where there is a possibility of significant effects on hearing or other physical effects, airgun operations will be powered down (or shut down if necessary) immediately.

During daylight, vessel-based observers will watch for marine mammals near the seismic vessel during all periods with shooting and for a minimum of 30 minutes prior to the planned start of airgun operations after an extended shut down. CPAI proposes to also conduct nighttime and daytime operations (though there will be little night at the start of the cruise). Marine mammal observers will not be on duty during ongoing seismic operations at night. At night, bridge personnel will watch for marine mammals (insofar as practical at night) and will call for the airgun(s) to be shut down if marine mammals are observed in or about to enter the safety radii. If the airguns are started up at night, two marine mammal observers will monitor marine mammals near the source vessel for 30 minutes prior to start up of the airguns using night vision devices.

Proposed Safety Radii

Received sound levels were modeled by CPAI for the two airgun configurations: (1) 16 gun with two eight-gun strings, and (2) 24 guns with three eight gun strings. Most (90%)of the survey will be done with 16 gun configuration. Pressure field was modeled in the horizontal plane at 20m of depth. Generally, water depths of survey area do not exceed 50m, except in rare locations at several isolated submarine canyons. Based on the model, the distances from the airgun(s) where sound levels of 190, 180, and 160 dB re 1 µPa (rms) are predicted to be received are shown Table 3.

Table 3. Estimated distances (m) sound levels ≥ 190, 180, and 160 dB RMS might be received from an array of 16 and 24 airguns used in seismic surveys in the Chukchi Sea.

Seismic Source	190dB (Safety Criterion for Seals)	180dB (Safety Criterion for Large Whales)	160dB (Assumed Onset of Behavioral Harassment)
16 Guns 3390 cu in (2 strings)	<150 m (0.15 km)	<250 m (0.25 km)	<700 m (0.7 km)
24 Guns 5085 cu in (3 strings)	<200 m (0.2 km)	<300 m (0.3 km)	<750 m (0.75 km)

RMS values referred to 1 μPa
RMS can be converted to Peak-to-Peak by adding 9 dB

Data will be acquired to verify the 190, 180, and 160 dB (rms) distances for the 16 (3390 cu in) and 24 (5085 cu in) airgun configurations during the 2006 seismic operations in the Chukchi Sea. A qualified person following a scientifically valid sampling design will collect data at the beginning of the seismic program. The data will be used to calibrate the CPAI model. The safety radii will be adjusted to match the field values for the 190, 180, and 160 dB distances for each array, if different from the estimated values in the IHA.

Airguns will be powered down (or shut down if necessary) immediately when marine mammals are detected within or about to enter the appropriate radius: 180-dB (rms) for cetaceans, and 190-dB (rms) for pinnipeds. The 180 and 190 dB shutdown criteria are consistent with guidelines listed for cetaceans and pinnipeds, respectively, by NMFS (2000) and other guidance by NMFS. CPAI is aware that NMFS is developing new noise-exposure guidelines, but that they have not yet been finalized or approved for use. CPAI will be prepared to revise their procedures for estimating numbers of mammals "taken", safety radii, etc., as may be required at some future date by the new guidelines.

Mitigation During Operations

In addition to monitoring, mitigation measures that will include (1) speed or course alteration, provided that doing so will not compromise operational safety requirements, (2) power-or shutdown procedures, and (4) no start up of airgun operations unless the full 180 dB safety zone is visible for at least 30 minutes during day or night.

During nighttime operations, if the entire safety radius is visible using vessel lights and NVDs (as may be the case in deep waters), then start up of the array may occur. However, lights and NVDs may not be very effective as a basis for monitoring the safety radii around the airgun(s). Nighttime startups of the airguns from a shut-down condition may not be possible. If the airguns have been operational before nightfall, they can remain operational throughout the night, even though the entire safety radius may not be visible.

The mitigation and marine mammal monitoring measures listed and described below will be adopted during the proposed seismic program, provided that doing so will not compromise operational safety requirements:

1. Speed or course alteration;
2. Shut down procedures;
3. Power-down procedures; and
4. Ramp-up procedures.

Speed or Course Alteration

If a marine mammal is detected outside the safety radius and, based on its position and the relative motion, is likely to enter the safety radius, the vessel's speed and/or direct course may, when practical and safe, be changed that also minimizes the effect on the seismic program. The marine mammal activities and movements relative to the seismic vessel will be closely monitored to ensure that the marine mammal does not approach within the safety radius. If the mammal appears likely to enter the safety radius, further mitigative actions will be taken, i.e., either further course alterations or power down or shut down of the airgun(s).

Power-down Procedures

A power down involves decreasing the number of airguns in use such that the radius of the 180-dB (or 190-dB) zone is decreased to the extent that marine mammals are not in the safety zone. A power down may also occur when the vessel is moving from one seismic line to another. During a power down, one airgun is operated. The continued operation of one airgun is intended to alert marine mammals to the presence of the seismic vessel in the area. In contrast, a shut down occurs when all airgun activity is suspended.

If a marine mammal is detected outside the safety radius but is likely to enter the safety radius, and if the vessel's speed and/or course cannot be changed to avoid having the mammal enter the safety radius, the airguns may (as an alternative to a complete shut down) be powered down before the mammal is within the safety radius. Likewise, if a mammal is already within the safety zone when first detected, the airguns will be powered down immediately if this is a reasonable alternative to a complete shut down.

Following a power down, airgun activity will not resume until the marine mammal has cleared the safety zone. The animal will be considered to have cleared the safety zone if it:

• Is visually observed to have left the safety zone, or
• Has not been seen within the zone for 15 min in the case of pinnipeds, or
• Has not been seen within the zone for 30 min in the case of whales.

Shut-down Procedures

The operating airgun(s) will be shut down completely if a marine mammal approaches or enters the then-applicable safety radius and a power down is not practical. The operating airgun(s) will also be shut down completely if a marine mammal approaches or enters the estimated safety radius of the source that would be used during a power down. The shutdown procedure should be accomplished within several seconds (of a "one shot" period) of the determination that a marine mammal is within or about to enter the safety zone.

Airgun activity will not resume until the marine mammal has cleared the safety radius. The animal will be considered to have cleared the safety radius if it is visually observed to have left the safety radius, or if it has not been seen within the radius for 15 minutes (beluga and seals) or 30 minutes (bowhead, gray, and killer whales).

Ramp-up Procedures

A "ramp up" procedure will be followed when the airgun array begins operating after a specified-duration period without airgun operations. Under normal operation conditions (4-5 knots) a ramp-up would be required after a "no shooting" period lasting 2 minutes or longer. NMFS normally requires that the rate of ramp up be no more than 6 dB per 5 minute period. The specified period depends on the speed of the source vessel and the size of the airgun array that is being used. Ramp up will begin with the smallest gun in the array that is being used for all subsets of the16 or 24-gun array. Guns will be added in a sequence such that the source level in the array will increase at a rate no greater than 6 dB per 5-minutes, which is the normal rate of ramp up for larger airgun arrays. During the ramp up (i.e., when only one airgun is operating), the safety zone for the full 16 or 24-airgun system will be maintained.

If the complete safety radius has not been visible for at least 30 minutes prior to the start of operations in daylight or nighttime, ramp up will not commence unless one gun has been operating during the interruption of seismic survey operations. This means that it will not be permissible to ramp up the 16 or 24 gun source from a complete shut down in thick fog or at other times when the outer part of the safety zone is not visible. If the entire safety radius is visible using vessel lights and/or NVDs (as may be possible under moonlit and calm conditions), then start up of the airguns from a shut down may occur at night. If one airgun has operated during a power-down period, ramp up to full power will be permissible at night or in poor visibility, on the assumption that marine mammals will be alerted to the approaching seismic vessel by the sounds from the single airgun and could move away if they choose. Ramp up of the airguns will not be initiated if a marine mammal is sighted within or near the applicable safety radii during the day or a night. For operations in the Chukchi during summer and autumn months, there will be enough daylight to monitor beyond a 12-hour cycle.

12. Where the Proposed Activity Would Take Place in or Near a Traditional Arctic Subsistence Hunting Area and/or May Affect the Availability of a Species or Stock of Marine Mammal for Arctic Subsistence Uses, the Applicant Must Submit Either a Plan of Cooperation or Information that Identifies What Measures have Been Taken and/or Will be Taken to Minimize any Adverse Effect on the Availability of Marine Mammals for Subsistence Uses.

CPAI will submit a plan of cooperation in the form of a Conflict Avoidance Agreement (CAA) before commencing seismic operations in 2006, and meet with key native organizations responsible for managing marine mammals in the arctic. CPAI will meet with the Alaska Eskimo Whaling Commission (AEWC) early in the planning for the 2006 seismic survey. In addition, CPAI will meet with the Alaska Beluga Whale Committee (ABWC), and North Slope Borough (NSB) as necessary. These meetings will provide information on the time, location, and features of the seismic survey/operations, opportunities for involvement by local people, potential impacts to marine mammals, and mitigation measures to avoid or minimize impacts. The plan of cooperation will be developed from these meetings and discussions so it reflects the concerns of the villages, hunters, and management agencies.

A number of actions will be taken by CPAI during the seismic surveys to minimize any adverse effect on the availability of marine mammals for subsistence, which have been identified in this application and will be further developed in the plan of cooperation. They include the following:

- Seismic surveys will largely occur outside of the prime periods for hunting marine mammals;
- Seismic surveys will be scheduled to occur in areas away from the villages during prime hunting periods, whenever possible;

- Seismic operation will follow procedures to avoid, power down, shut down, and ramp up within specific safety radii to minimize effects on the behavior of marine mammals and, therefore, opportunities for harvest by local communities;
- Operations will be managed to stay beyond any hunter encountered within 5 km of the seismic vessel when shooting airguns;
- North Slope Borough residents will be hired on the seismic vessel to assist marine mammal biologists in monitoring operations and their affect on marine mammals.

The combination of the timing, location, mitigation measures, and input from local communities and organization will minimize the effect of the seismic surveys on availability of marine mammals for subsistence uses.

13. The Suggested Means of Accomplishing the Necessary Monitoring and Reporting that will Result in Increased Knowledge of the Species, the Level of Taking or Impacts on the Population of Marine Mammals That are Expected to be Present While Conducting Activities and Suggested Means of Minimizing Burdens By Coordinating Such Reporting Requirements with Other Schemes Already Applicable to Persons Conducting Such Activity. Monitoring Plans Should Include a Description of The Survey Techniques That Would Be Used to Determine the Movement and Activity of Marine Mammals Near The Activity Site(s) Including Migration and Other Habitat Uses, Such As Feeding.

CPAI's proposed Monitoring Plan is described below. CPAI understands that this Monitoring Plan will be subject to review by NMFS and others, including discussions at the Beaufort Sea open-water review meeting that NMFS plans to convene in the spring of 2006, and that refinements may be required.

The monitoring work described has been planned as a self-contained project independent of any other related monitoring projects occurring simultaneously in the same regions. CPAI is prepared to discuss coordination of its monitoring program with any related work be done by other groups insofar as this is practical and desirable.

Vessel-based Visual Monitoring

Vessel-based observers will monitor marine mammals near the seismic vessel during (1) all daytime hours; (2) start ups, and (3) at night when marine mammals are suspected of either approaching or within the safety radii. When feasible, observations will also be made during daytime periods during transits and other operations when guns are inactive.

During seismic operations observers will be based aboard the vessel. Marine mammal observers (MMOs) will be hired by CPAI, with NMFS consultation. One resident from the North Slope Borough, preferably from Point Hope, Point Lay, Wainwright, or Barrow who is knowledgeable about marine mammals of the project area will to be included in the MMO team aboard the vessel. Observers will follow a schedule so at least two observers will simultaneously monitor marine mammals near the seismic vessel during ongoing daytime operations and nighttime start ups of the airgun. Use of two simultaneous observers will increase the proportion of the animals present detected near the source vessel. MMO(s) will normally be on duty in shifts no longer than 4 hours. The vessel crew will also be instructed to assist in detecting marine mammals and implementing mitigation requirements (if practical). Before the start of the seismic survey the crew will be given additional instruction on how to do so.

The vessel is a suitable platform for marine mammal observations. When stationed on the flying bridge, the eye level will be ~10 m (32.8 ft) above sea level, and the observer will have an unobstructed view around the entire vessel. If surveying from the bridge, the observer's eye level will be about 10 m (32.8 ft) above sea level and ~25° of the view will be partially obstructed directly to the stern by the stack. During daytime, the MMO(s) will scan the area around the vessel systematically with reticle binoculars (e.g., 7 × 50 Bushnell or equivalent) and with the naked eye. Laser range finders (Leica LRF 1200 laser rangefinder or equivalent) will be available to assist with distance estimation. They are useful in training observers to estimate distances visually, but are generally not useful in measuring distances to animals directly. During darkness, NVDs (Night Vision Device) will be available (ITT F500 Series Generation 3 binocular-image intensifier or equivalent), if and when required.

When mammals are detected within or about to enter the designated safety radius, the airgun(s) will be powered down (or shut down if necessary) immediately. The observer(s) will continue to maintain watch to determine when the animal(s) are outside the safety radius. Airgun operations will not resume until the animal is outside the safety radius. The animal will be considered to have cleared the safety radius if it is visually observed to have left the safety radius, or if it has not been seen within the radius for 15 minutes (beluga whales and seals) or 30 minutes (gray, bowhead, and killer whales).

All observations and airgun shut downs will be recorded in a standardized format. Data will be entered into a custom database using a notebook computer. The accuracy of the data entry will be verified by computerized validity data checks as the data are entered and by subsequent manual checking of the database. These procedures will allow initial summaries of data to be prepared during and shortly after the field program, and will facilitate transfer of the data to statistical, graphical, or other programs for further processing and archiving.

Results from the vessel-based observations will provide

1. The basis for real-time mitigation (airgun shut down).
2. Information needed to estimate the number of marine mammals potentially taken by harassment, which must be reported to NMFS.
3. Data on the occurrence, distribution, and activities of marine mammals in the area where the seismic study is conducted.
4. Information to compare the distance and distribution of marine mammals relative to the source vessel at times with and without seismic activity.
5. Data on the behavior and movement patterns of marine mammals seen at times with and without seismic activity.

Reporting

A report will be submitted to NMFS within 90 days after the end of the project. The report will describe the operations that were conducted and the marine mammals that were detected near the operations. The report will be submitted to NMFS, providing full documentation of methods, results, and interpretation pertaining to all monitoring. The 90-day report will summarize the dates and locations of seismic operations, and all marine mammal sightings (dates, times, locations, activities, associated seismic survey activities). The report will also include estimates of the amount and nature of potential "take" of marine mammals by harassment or in other ways.

Mitigation Measures Not Proposed

CPAI does not intend to conduct aerial surveys during the seismic operations for the following reasons:

- Seismic surveys will not affect subsistence whaling conducted by villages bordering the project area. The spring whale hunt will be over before seismic operations begin, and the fall whale hunt will be east of the project area. The beluga hunt at Point Lay will be considerably east of the project area. Consequently, there is no chance of the seismic operations affecting the availability of whales for subsistence.

- Seismic surveys will mostly occur outside the prime period for hunting seals. Moreover, seismic surveys have not been shown to displace seals from their habitat. Aerial counts of seals are only reliable in spring when they are basking on ice, which will be before seismic operations begin. Open water, aerial counts of seals are unreliable. Seals will be more effectively monitored from the seismic vessel during seismic operations.

- NMFS has established guideline for setting safety radii along with mitigation and monitoring procedures for minimizing impacts of airgun noise on arctic marine mammals. CPAI has established safety radii based on the guidelines, which will be followed along with mitigation and monitoring procedures throughout the seismic operations. Strict adherence to the guidelines and employment of qualified observers on the vessel replace the role of aerial surveys. Vessel-based observers will be more effective than aerial surveys because observers will watch for marine mammal during all of the daylight hours, whereas aerial observers would be limited to a small time window during the day.

- Aerial surveys in this region are quite dangerous to conduct because of the remoteness and distance from land for much of the project area. In addition, surveys would likely occur in the fall, which is when weather conditions are most unpredictable and icing is an issue. A UFSWS plane surveying for polar bears was lost and all on board died in the fall of 1990 in the project area, which occurred coincidental to another aerial survey conducted for Shell and Chevron in same region. For these and other reasons aerial surveys should only be considered if there are no safer avenues for monitoring marine mammal responses to seismic operations. We believe the vessel provides a safe and effective platform for accomplishing the monitoring program.

CPAI will consider conducting an aerial survey monitoring program if required by NMFS, but requests that NMFS consider the years of effort put forth to develop scientifically-based guidelines currently used for managing seismic operations to minimize disturbance to marine mammals. Implementation of these guidelines combined with vessel based monitoring should eliminate the need for aerial surveys for most projects including the proposed project and thereby reduce the safety risk to MMO's, pilots and crews.

14. Suggested Means of Learning of, Encouraging, and Coordinating Research Opportunities, Plans, and Activities Relating to Reducing such Incidental taking and Evaluating its Effects.

Open-water seismic operations have been conducted in the Alaska Arctic region for over 25 years and, during this time there have been no noticeable adverse impacts on the marine mammal populations or their availability for subsistence uses. Bowheads, gray whales, and other species have increased to where they are approaching or at carrying capacity of the habitat. The bowhead whale harvest has been very consistent over the last ten years among the whaling villages, averaging 44 whales landed per year (range of 30-49), suggesting no decrease in their availability for harvest. While the status of the other stocks is uncertain due to a lack of current data, there is no firm information to suggest the populations are declining or less available for harvest. Consequently, the past seismic activity has had no more than a negligible affect on the marine mammal populations.

However, to further ensure that there will be no adverse effects resulting from open water seismic operations, CPAI will continue to cooperate with the NMFS, MMS, USFWS, other appropriate federal agencies, the State of Alaska, the North Slope Borough, AEWC, ABWC, the affected communities, and other monitoring programs to coordinate research opportunities and assess all measures than can be taken to eliminate or minimize any impacts from these activities.

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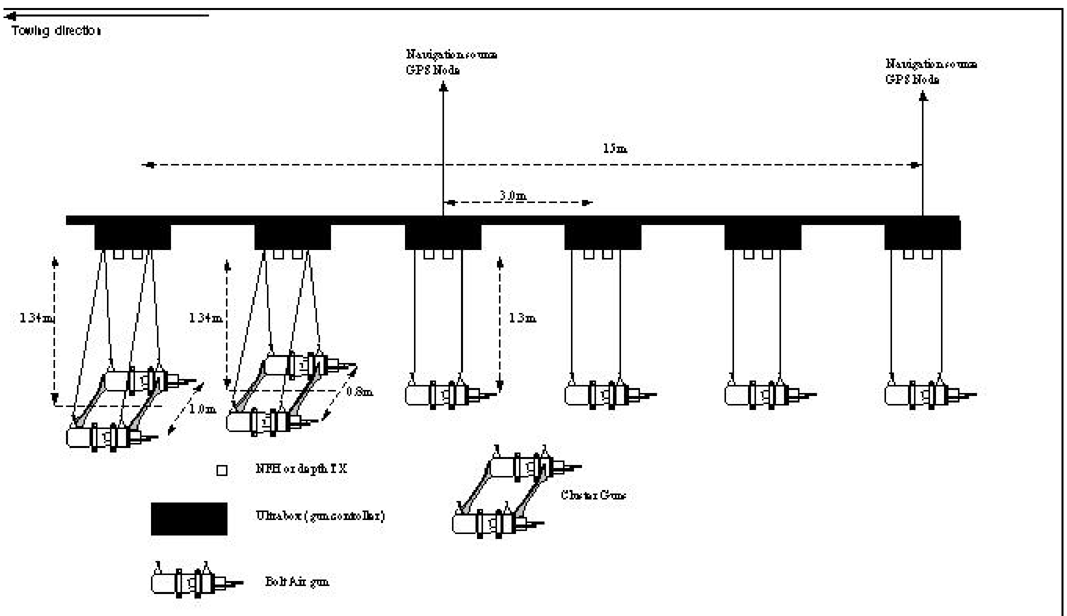
WesternGeco's 3390 cu.in. Bolt Gun Array for 3D Operations

WesternGeco's source arrays are composed of identically tuned Bolt gun sub-arrays operating at 2000 psi air pressure. In general, the signature produced by an array composed of multiple sub-arrays has the same shape as that produced by a single sub-array while the overall acoustic output of the array is determined by the number of sub-arrays employed. In this manner WesternGeco can offer a consistent source signature across our fleet of survey vessels.

The gun arrangement for the 1695 in^3 sub-array is diagrammed below.

Standard 1695 cu.in. sub-array



As indicated in the diagram, the sub-array is composed of six tuning elements; two 2-gun clusters and four single guns. The clusters have their component guns arranged in a fixed side-by-side fashion with the distance between the gun ports set to maximise the bubble suppression effects of clustered guns. A near-field hydrophone is mounted about 1 m above each gun station (one phone is used per cluster), one depth transducer per position is mounted on the gun's ultrabox, and a high pressure transducer is mounted at the aft end of the subarray to monitor high pressure air supply. All the data from these sensors are transmitted to the vessel for input into the onboard systems and recording to tape.

The standard configuration of a source array for 3D surveys consists of one or more 1695 in^3 sub-arrays. When more than one sub-array is used the strings are lined up parallel to each other with either 8 m or 10 m cross-line separation between them. This separation had been chosen so as to minimise the areal dimensions of the array in order to approximate point source radiation characteristics for frequencies in the nominal seismic processing band. For the 3390 in^3 array the overall dimensions of the array are 15 m long by 10 m wide.

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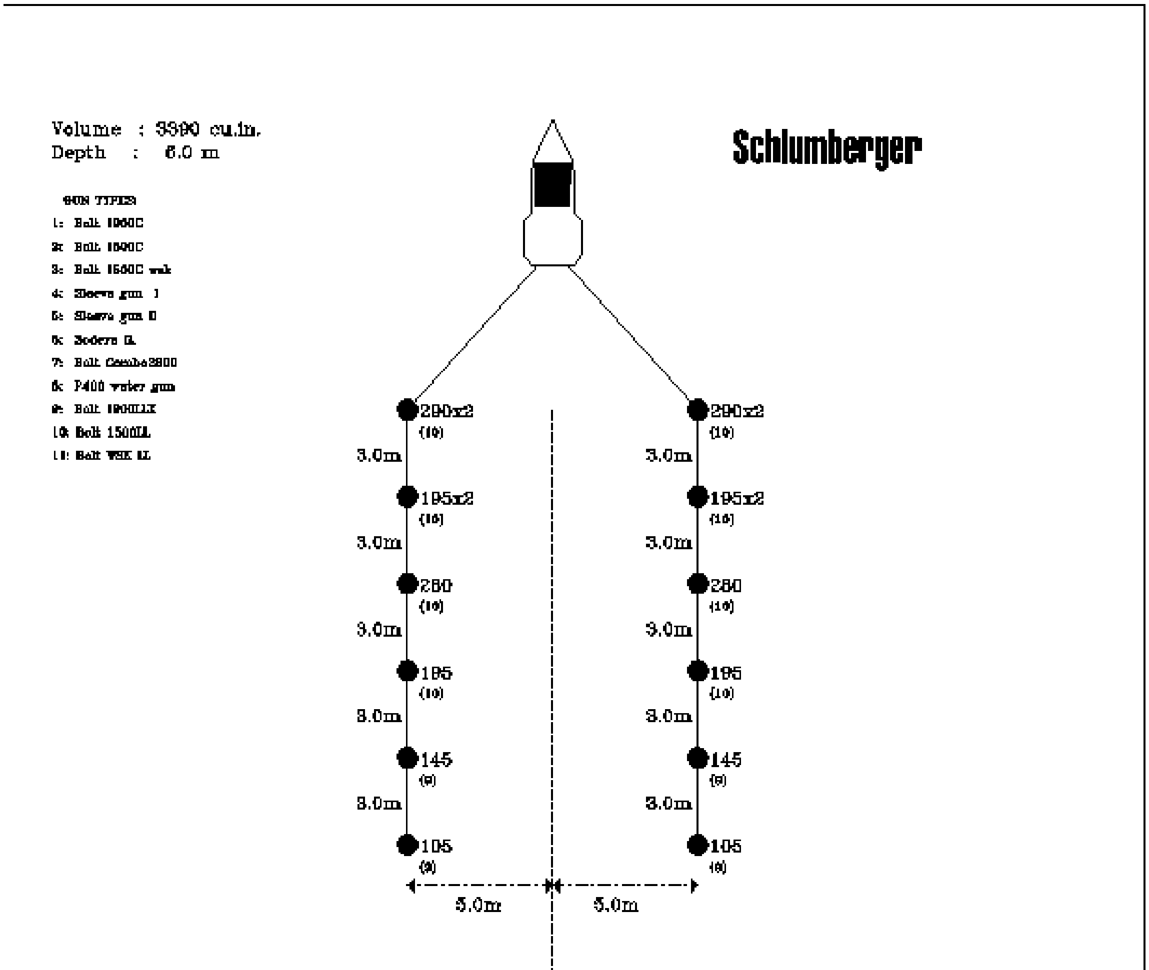
The following diagram shows the array geometry. There are two positioning sensors generally located at the front and aft of each string and include purpose build rGPS pods and acoustic pods.

3390 cu.in. Array Geometry



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3390 cu.in. Array Signature and Acoustic Radiation Patterns

The following pages show the time series and amplitude spectrum for the far-field signature and the computed acoustic emission pattern for the vertical inline and crossline planes for the 3390 in^3 array with guns at a depth of 6 metres.

The signature for this array was computed using GSAP, WesternGeco's in house signature modelling software. The following table lists the gun parameters used as input to the model.

1695 cu.in. Sub-Array Gun Position Table

Gun Number	Volume (cu.in.)	Inline Position (m)	Crossline Position (m)	Tow Depth (m)	Model
1,2	290	0.0	0.5, -0.5	6.25	1500 ll
3, 4	195	3.0	0.4, -0.4	6.25	1500 ll
5	280	6.0	0.0	6.0	1500 ll
6	195	9.0	0.0	6.0	1500 ll
7	145	12.0	0.0	6.0	1900 llx
8	105	15.0	0.0	6.0	1900 llx

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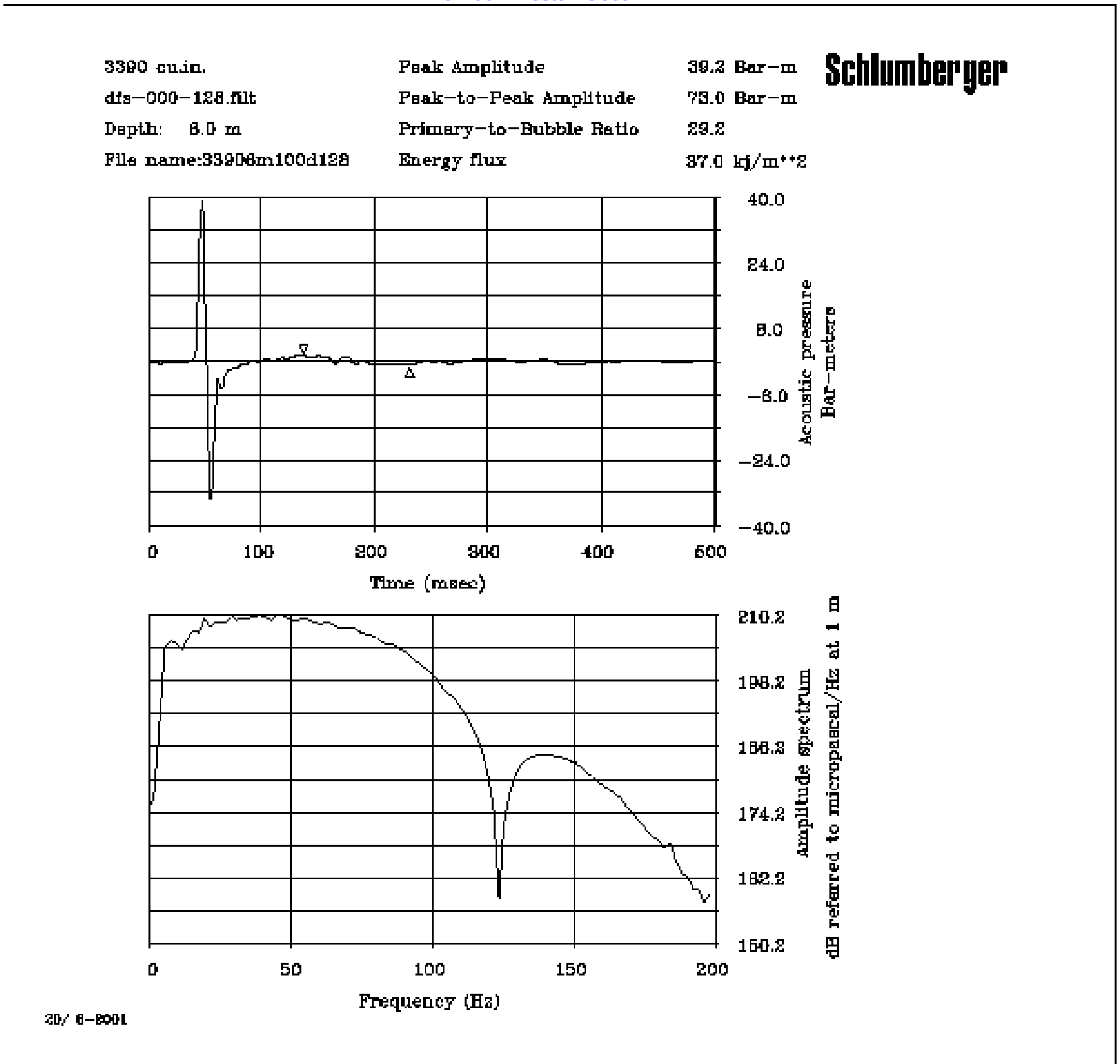


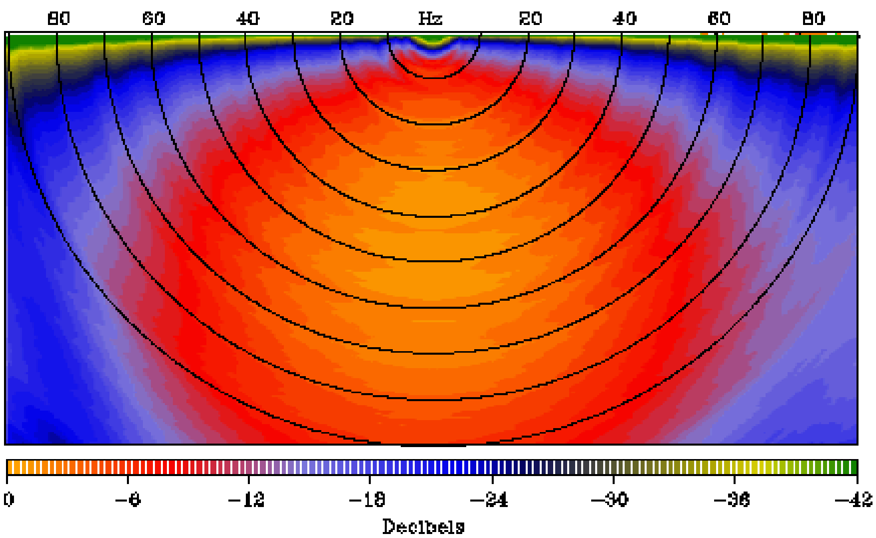
Volume	3390 in³
Depth (meters)	6
Filter (hertz)	0 – 128 (72) DFS V
Peak Output (bar-m)	39.2
Peak-Trough Output (bar-m)	73.0
Peak/Bubble Ratio	29.2

The acoustic emission pattern plots (for an array depth of 6m) show that the energy emitted by the array is uniformly distributed in the inline and crossline directions. This is a desirable feature for an array used to acquire 3D seismic data.

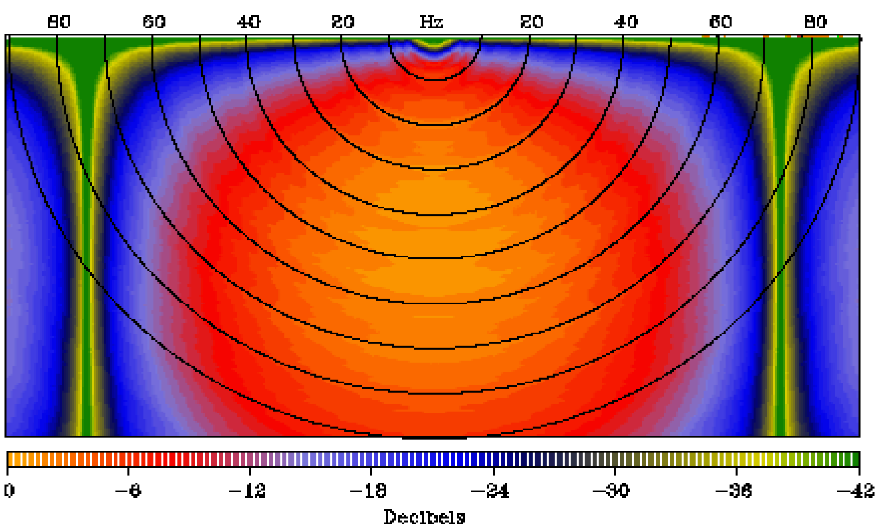
Schlumberger

ANGULAR RESPONSE

Array response in polar coordinates.
Frequency along the radial axis.



Array: arr−3390−6m−100
Depth(m): 6.0
Azimuth(Deg): 0.0



Array: arr−3390−6m−100
Depth(m): 6.0
Azimuth(Deg): 90.0

3390 cu.in. Array Far Field Pressure Distribution

Commercial modelling package, Nucleus, was used to produce plots of peak-to-peak pressure in the horizontal plane at 20 m depth.

The results are restricted to 0-1000Hz bandwidth due to internal sample rate of .5 ms.

The following figures demonstrate modeled pressure field around the array. For the purposes of measuring safe distances the worst case scenario (in-line with the source) is chosen

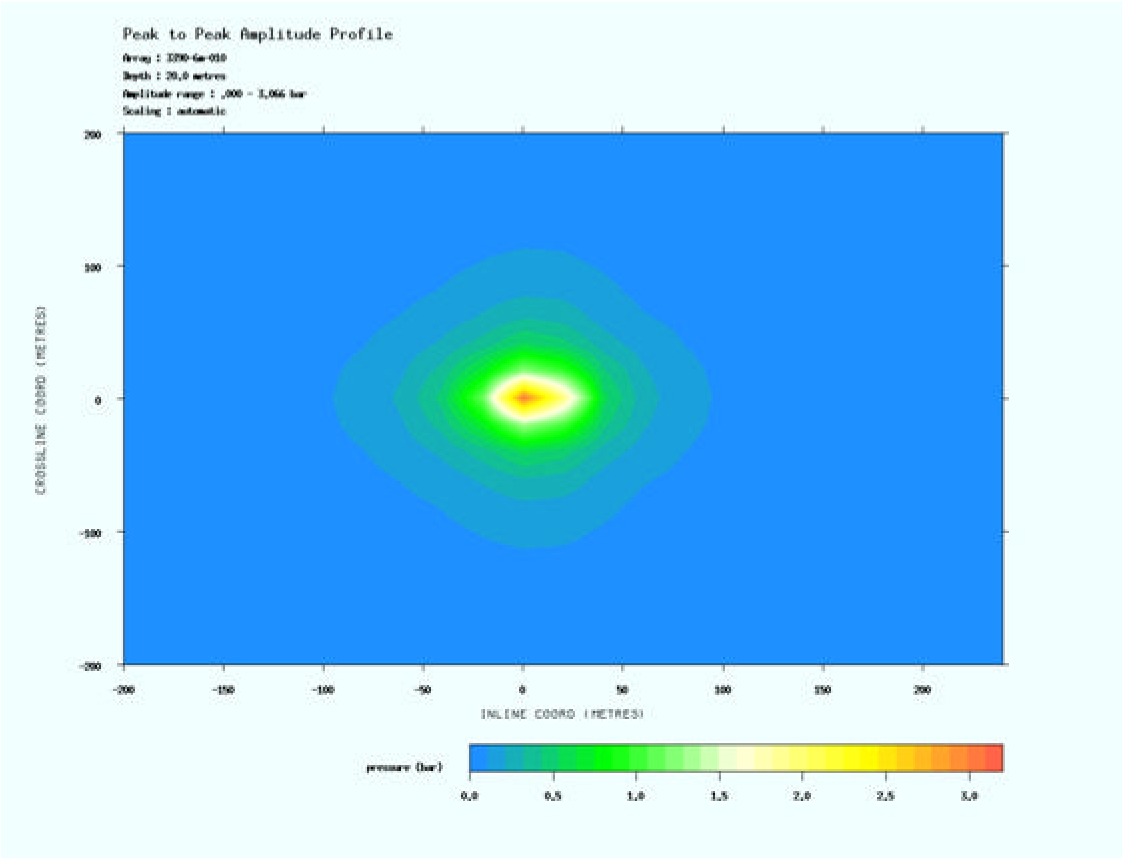


Figure 1 Pressure field at 20m depth. Peak to Peak amplitude, area centered on the array.

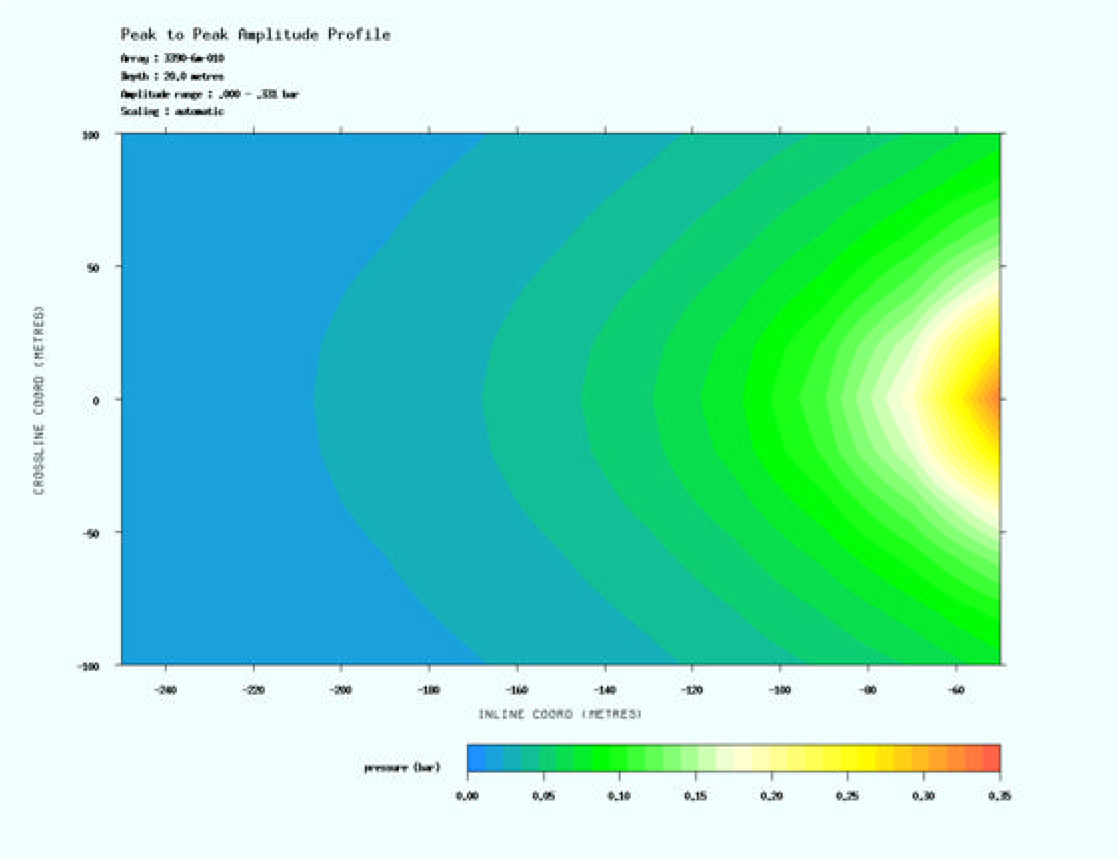


Figure 2 Pressure field at 20m depth. Peak to Peak amplitude, zoom in to highlight .09 Bar.

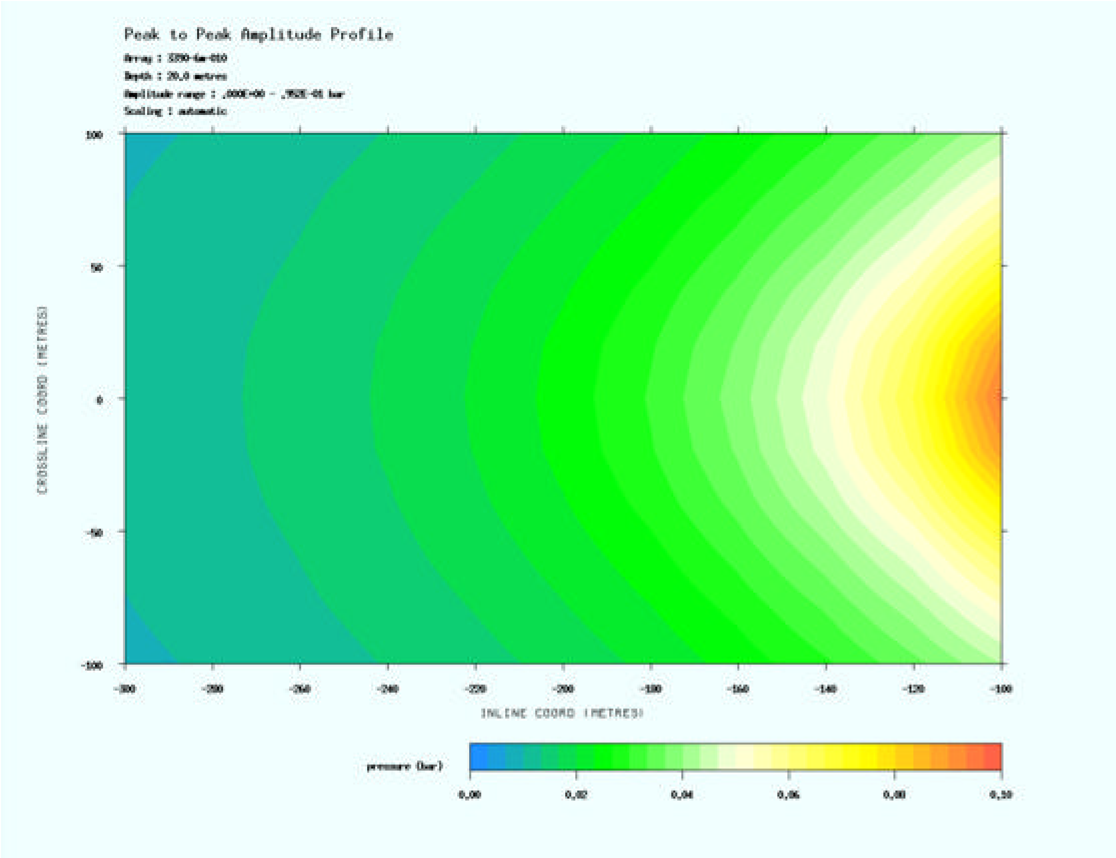


Figure 3 Pressure field at 20m depth. Peak to Peak amplitude, zoom in to highlight .03 Bar.

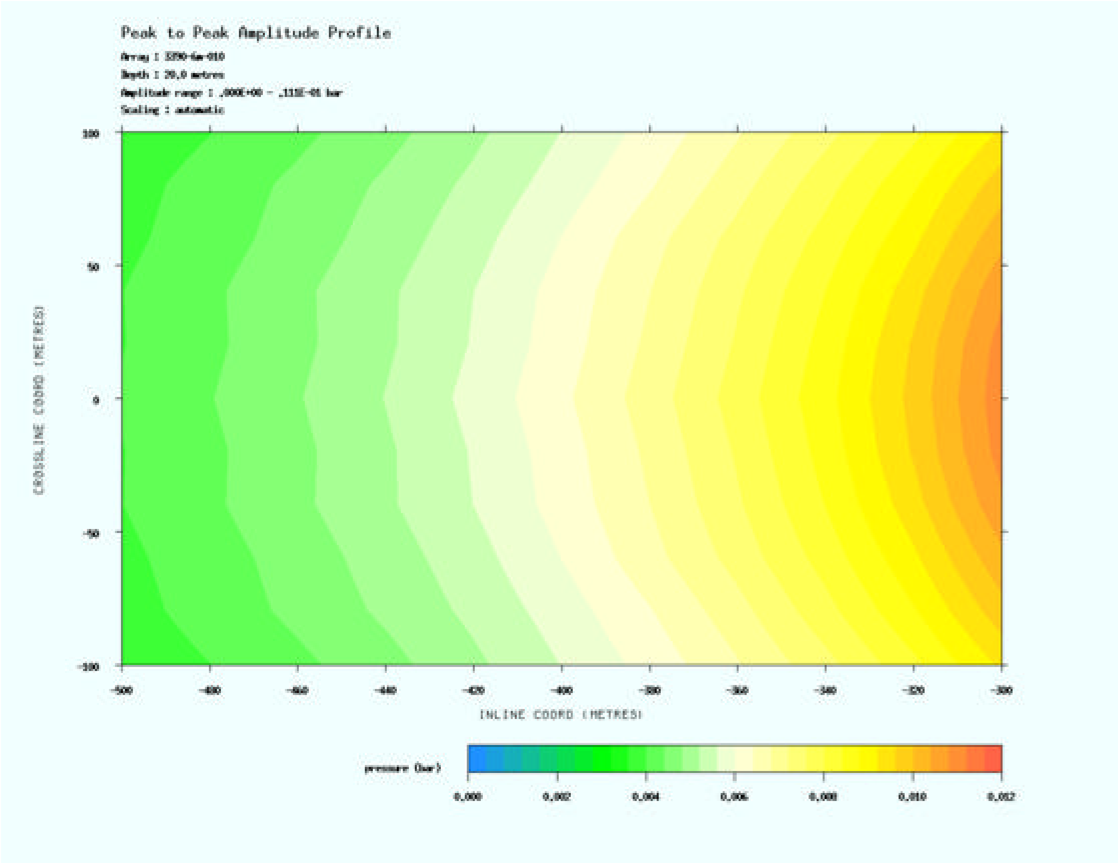


Figure 4 Pressure field at 20m depth. Peak to Peak amplitude, zoom in to highlight .009 Bar.

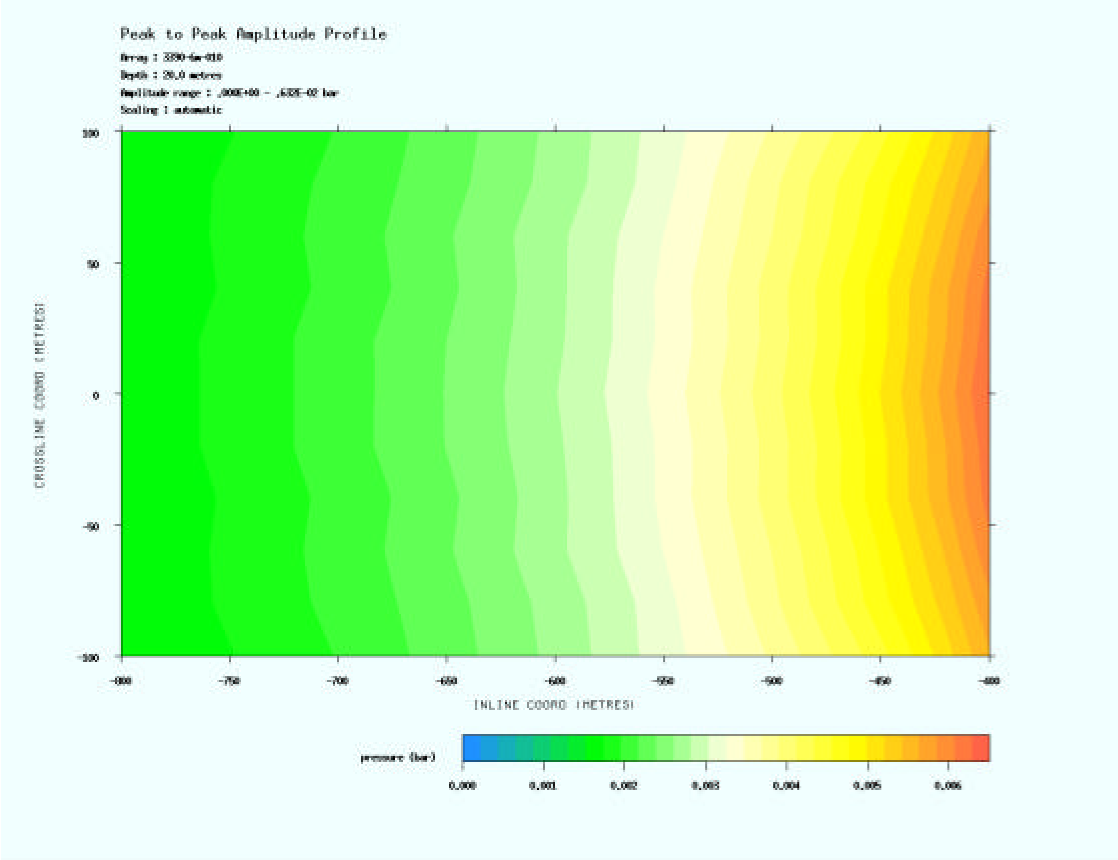


Figure 5 Pressure field at 20m depth. Peak to Peak amplitude, zoom in to highlight .003 Bar.